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COMPRESSED AIR

MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XVIII

JANUARY, 1913

No. 1



FIG. 1. AIR MOTOR HOISTS IN PRATT & WHITNEY FOUNDRY, HARTFORD, CONN.

COMPRESSED AIR IN FOUNDRY PRACTICE

We present here an abstract of a paper read at the Buffalo meeting of the American Foundrymen's Association by Mr. Arthur F. Murray, East Cambridge, Mass. The paper was copiously illustrated, but the half-tones here presented are from a paper upon the same topic by Mr. W. H. Armstrong, New York city, read at the Boston meeting of the New England Foundrymen's Association. In presenting this matter in this combination we follow the lead of Foundry in its December issue.

To say that no foundry should be without

an adequate supply of compressed air is almost as trite as to say that no steam power plant should be without steam. But in spite of the many advantages that the user of pneumatic appliances has over the foundryman who is without them, many foundries throughout the country are without any supply of compressed air and a larger number make less use of it than they should.

It is not the purpose of this paper to present a scientific treatise on compressed air or a mass of figures as to costs of operation and resultant savings. These are so dependent on individual conditions that figures drawn from

general statements would be of little value. I shall merely attempt to outline the uses to which compressed air is put by the wide-awake foundryman.

It may be well to list the more important uses for compressed air in the foundry, starting with the handling and mixing of materials and proceeding through the core and molding shops to the cleaning room and shipping floor.

Applications of compressed air:

Handling Materials.

Air hoists.

Pneumatic elevators.

Power squeeze, power roll-over, power-draft types.

Power sucker types with vibrator.

Pneumatic rammers.

Pneumatic molding sand sifters or riddles.

Blow guns.

Spraying devices.

Cleaning Room.

Pneumatic chippers.

Sand blasts, high or low pressure.

Sand blast tumbling barrels.

The air elevator is used frequently in place of the hydraulic elevator for sand pits or other



FIG. 2. ANOTHER VIEW OF THE MOTOR HOIST INSTALLATION.

Pneumatic cupola charging machines.

Fuel oil systems.

Core Shops.

Core carriage hauling devices.

Core sand preparation (pneumatic riddles).

Coremaking machines, jolt ram type.

Coremaking machines, roll over type.

Molding Floor.

Molding machines:

Plain jolt or jarring type.

Combination jarring and squeezing types.

Combination jolt ram and pattern drawing types.

Plain vibrator types, power squeeze types.

Power squeeze, power-draft types.

places where the hydraulic elevator would require the installation of long lines of large piping, expensive pump installations and trouble from freezing. It is simple, cheap and effective, although not to be recommended for the continuous service of the cupola stage. Where the lift is long, indirect air elevators, similar to the indirect hydraulic elevators used in office buildings are frequently employed.

A great many foundries use fuel oil for skin drying, melting furnaces, core ovens, etc. The air displacement system is a simple means of transporting this from the place of storage to the place of use. In this system air is not applied directly to the storage tanks but alter-

nately to two small pressure tanks which receive their supply of oil by gravity from the main storage tanks. Simple cross-over valves are used and are changed over once or twice a day, usually by hand, but sometimes automatically.

Compressed Air in the Core Room.

The core room is often a neglected part of an otherwise up-to-date plant. Therefore, opportunities for savings are usually good. If core costs can be sufficiently reduced, the entire molding practice may be radically changed, coring taking the place of difficult pockets, loose part work or multiple part flasks. Jolt

work, or requires as little special pattern and flask work.

One of the most essential requirements for the profitable operation of jarring machines is efficient crane service. Nothing will show up the crane service like the presence of a good sized jarring machine on the molding floor. Inefficient crane service in a hand-molding foundry of course means idle time for the molder, but he will usually not make much of a row about that. When the jarring machine comes in, the foreman and manager are watching it and delays caused by the crane are quickly noted. In properly operating the jarring ma-



FIG. 3. THE USE OF PNEUMATIC SAND RAMMERS FOR MAKING LARGE MOLDS.

machines for making cores are meeting with increasing favor. For success on core jolt machines, boxes must be substantially built or they will be knocked to pieces. But the cost of a well-built core box is little more than that of a poorly built one, and the use of core jolt machines will reduce most core costs 25 to 50 per cent.

One of the most remarkable changes in foundry practice during the past five years has been caused by the general adoption of the jarring machine, jolt-rammer, bumper, or bouncer, as it is variously termed by makers and users. No other single type of molding machine is applicable to as wide a range of

chine, molds are set up on the floor, clamped, picked up by the crane, carried to the machine and rammed, picked up again and turned over, and then carried to the finishing floor by the crane. In connection with the jar-ramming machine in our foundry, I have found it profitable to install 5-ton independent high-speed auxiliary hoists on each of the two 60-foot traveling cranes, as well as in a 2-ton electric jib crane and an 8-inch air hoist.

The jarring machine, though covering a wide range of work, is not a universal panacea for high costs and poor castings. For specialty work the plain hand squeezer with vibrator attachment is widely used. For this same class



FIG. 4. HAMMER FOR BENCH WORK.

of work the ramming is sometimes done by hand or on a plain squeezer, and the pattern drawn by a sucker with vibrator attachment.

The very fact that there are so many types of air-operated molding machines only emphasizes the previous statement that air is to the foundry what steam is to the power plant.

The subject of sand-blasting is so broad that it can only be treated adequately in a separate paper. However, compressed air is used extensively for cleaning castings. For cleaning small castings that are not fragile the sand blast tumbling barrel renders excellent service. There are a number of machines built on the principle of a rotating barrel with one or both heads stationary. A nozzle or nozzles from a regular sand blast machine is inserted through openings in these heads. Most of these machines operate on the low pressure system. Some return the sand to the machine by a suction system and some by gravity. They all operate inside of an outer case closed by sliding, swinging or rolling door, and connected to an exhaust system.

An efficient sand blast or sand blast tumbler, either of the high or low pressure type,

will remove sand and scale, and will leave castings better looking than either a plain rumbling machine or the emery brick, wire brush and pickling tank. Castings have been cleaned and their cores cut out in less than an hour each with the sand blast that could not be cleaned by hand in two days. I know of one plant where a sand blast tumbling barrel replaced a pickling tank with the result that shipments could be made at least one day earlier than before. The product required galvanizing and was sandblasted and put in the galvanizing bath the day after it was cast instead of losing a day in the pickling vat.

The casting now being clean the fins, etc., are chipped off with a pneumatic chipping hammer. One man chipping with a chipping hammer is as good as two or three with hand chisel and sledge, and the work looks better and smoother. A skilled chipper will quickly remove fins or bunches so that they appear scarcely to have existed.

A few words about the care and upkeep of pneumatic tools. Before attaching a tool, blow out the air line and squirt oil into the valve. Do not use an air hammer all day long without oiling it. If the hammer has not been used for some time, squirt a little kerosene or benzine into it, connect up the hose, operate

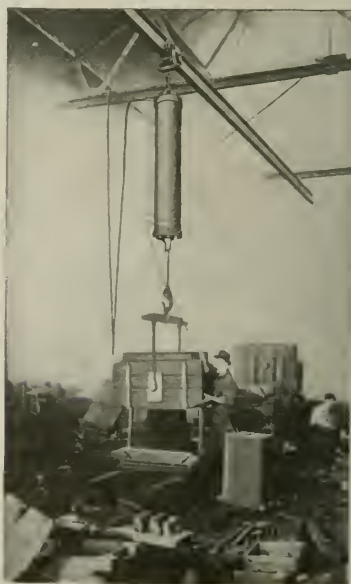


FIG. 5. AIR HOIST FOR HANDLING MOLDS.

the machine for a few strokes, then disconnect and squirt a light machine oil, or sewing machine oil, into the hammer. Several of the large oil refiners now supply a special pneumatic tool oil which should be used if possible. New hammers are always furnished with a gauze strainer. This should be kept in good condition as rubber particles and rust from hose and pipes are liable to clog valve passages if allowed to get into hammers. It is a good plan to suspend the hammers over night in a bath of kerosene to clean them out and to prevent rusting from moisture in the air. They must then be lubricated before using, as the kerosene leaves them dry. There are a num-

separators or they may be air receivers. It is a good plan to locate a steel receiver of 25 to 50 cubic feet capacity at points where there are large fluctuations in compressed air demands. This combines the action of separator and equalizer, although it will not sustain the service if the compressor shuts down. Fittings should be of the long-turn type and all shut-off valves of the gate type. All shut-off cocks on taps should be of heavy pattern and good quality. The piping should be installed with care to insure a tight line and should be well-supported so that the joints cannot shake loose. A single $\frac{1}{8}$ -inch orifice will deliver 21.2 cubic feet of free air per minute at 80 pounds pres-



FIG. 6. THE USE OF PNEUMATIC CHIPPING HAMMERS FOR CLEANING.

ber of makes of automatic oilers on the market to be attached to the air line a few feet from the hammer. If none of these is used the hammer should be oiled several times a day. Chisels should be kept in shape and in general the hammer should be treated as if it were a piece of machinery rather than a piece of scrap iron.

Piping should be as direct as possible with no undrained pockets or loops where moisture can accumulate and where freezing can occur in cold weather. Separators should be installed at low points on the line. These may

be either the ordinary type similar to steam sure. Hose should be heavy and preferably armored. Quick-acting couplings should be supplied at both ends of the hose to prevent the reprehensible practice of twisting it before screwing it into a tool connection.

After-coolers and reheaters are usually unnecessary with foundry outfits, but where there is a plentiful supply of cooling water the use of a properly proportioned after-cooler will remove nearly all the moisture from the air before discharging the air into the pipe line.

The average jobbing foundry requires a com-



FIG. 7. JIB CRANES PROVIDED WITH AIR MOTORS.

pressor of 300 to 500 cubic feet per minute displacement. Large foundries may use up to 1,500 or 2,500 cubic feet. Specialty foundries frequently require small machines of 50 to 100 cubic feet displacement. In selecting a foundry compressor, price should not be considered so much as service. The foundry compressor should be as nearly dirt-proof and fool-proof as possible. Machines that would give perfect satisfaction when operated in connection with a power plant and in charge of skilled engineers frequently go to pieces when installed in a foundry where skilled mechanics are not available, and where dirt and dust abound. These remarks refer not so much to the large foundry which maintains a power plant either for itself or jointly with other departments of the works, as to the independent jobbing foundry which produces a large percentage of our total foundry product.

In discussing compressed air in the foundry one could easily digress in many directions, for compressed air is so thoroughly applied in the up-to-date casting shop that a discussion of its use is a discussion of modern foundry practice.

EARLY HISTORY OF THE BESSEMER PROCESS

Some interesting early history of the Bessemer process is given by F. P. Wellman, in the *Journal of the Cleveland Engineering Society*, November, 1912. The information presented by him was received at the time of a visit he made to Sir Henry Bessemer, in company with Andrew Carnegie. Bessemer explained that the reason he was first induced to think of an experiment with a new process of iron making was the knowledge which came to him that the emperor, Louis Napoleon, was seeking a material to make better artillery than was then in use.

Bessemer's first idea was that he could make an improved wrought iron by blowing air through the liquid iron, instead of stirring it with a rabble to bring it in contact with metallic oxides, as was the practice in the puddling furnaces. To carry out this idea, he constructed a small stationary converter of fire-brick. This was about three feet inside diameter, and much more in height. The pipes, or tuyeres entered at the side not much above the bottom. They were all connected with the

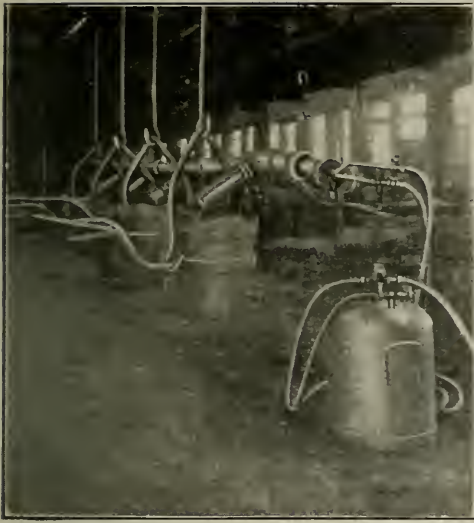


FIG. 8. HEATING FOUR LADLES WITH ONE BURNER.

blast box, which encircled the converter, a pipe leading from this to the blowing engine.

The converter was covered and the hole in the side, near the top, was left as an outlet for the flames. When it was finished he sent to the iron store for a ton of pig iron—no other specification, anything would do so long as it was pig iron. Here was Bessemer's lucky day. He knew nothing at that time about the chemistry of iron or what composition was necessary in the iron to make good steel, so it was pure chance that it so happened that the iron, "Blaenavon," sent to fill this order was the only brand made in all England at that time that would have made good malleable steel under the conditions by which it was made. It was low in phosphorus and sulphur, high in silicon, and contained a little manganese.

So the first trial was successful in making a metal that when tried in a neighboring iron works rolled and hammered successfully. The bars were treated in many ways, both hot and cold, and proved to be so strong and tough that it created a great deal of interest in all who saw it. Bessemer said that if the steel had been made from any other brand of iron made in Great Britain that the result would surely have been a worthless metal, brittle and rotten at all temperatures, and that he would have abandoned the experiment at once. Certainly, it was a lucky chance that he sent to that particular iron dealer.



FIG. 9. COMPRESSED AIR OIL BURNER FOR LIGHTING CUPOLA.

COMPRESSING NATURAL GAS*

By E. D. LELAND.

The average original rock pressures in the gas fields, 825 lb. per sq. in., in Pennsylvania; 450 lb., in Ohio; 326 lb., in Indiana; 1000 lb., in West Virginia; and 400 lb., in Kansas, have diminished greatly, in some cases to less than atmospheric pressure. On the other hand, consumption has increased enormously. To conduct the required output through long pipe lines of reasonable diameter, it is now customary to compress the gas near the point of production, and sometimes also at relay stations along the line. For example, a 16-in. line 100 miles long, with an initial pressure of 100 lb., and a terminal pressure of 10 lb., would carry about 12,700,000 cu.ft. per 24 hours; raising the initial pressure to 350 lb., would increase the delivery to 41,300,000 cu.ft. Ex-

*Portion of paper before Eng. Soc. of Western Pennsylvania.

haust pumps at the delivery ends of pipe lines have not been found satisfactory.

Gas compressors for this service are practically identical with air compressors, but are designed to operate at higher pressures, and with a medium containing more or less grit. The desirable features of such a compressor are: A long stroke and slow rotation, together involving a piston speed of not over 650 ft. per min.; conical cylinder heads; solid, one-piece, poppet valves with short lifts; removable liners in the compressing cylinders; and adequate piston strength and bearing surface. Water jackets are essential.

For motive power, the cross-compound Corliss engine, direct-connected to the compressing cylinders, is preferred, for the following reasons: (1) Reliability of operation and endurance; (2) ability to start at slow speed; (3) adaptability to the long, slow stroke found most efficient in gas compressing; (4) flexibility and high overload capacity; these are specially desirable features for this work, as the inlet and delivery gas pressures are liable to sudden and violent fluctuations; (5) cheapness compared to a gas engine of equal capacity.

The only serious competitor of the steam engine for this work is the internal-combustion engine, and this the author deprecates on account of its high speed, both while starting, and normally; its inability to handle an overload; its unreliability except under the most skillful management; and the danger introduced by having a combustion engine and an inflammable compressed gas in the same room. The larger sized slow-speed gas engines have been found liable to cracking of the cylinders, due probably to difficulty in jacket circulation, and the present tendency is toward smaller units.

GAS USUALLY USED FOR FUEL

For fuel, most of the compressing plants in the country are now using gas, in the ratio of 1 to 5 per cent. of the amount delivered. At a modern station in West Virginia, the recent test on a 31x68x60-in. Corliss engine showed a consumption of only 13.36 cu.ft. of gas per i.h.p.-hour. Where the market for gas is exceptional, and the compressing plant is near an oil or a coal field, and is on a railroad, the use of these latter fuels is recommended. One ton of Pittsburgh coal, or 180 gal. of Texas petroleum, is about equivalent in heat units to 18,000 cu.ft. of natural gas. The boilers are always situated in a separate building at a

distance from the compressors. The cost of erecting a steam-operated plant ranges from \$30 to \$90 per hp. The operating cost per hp.-hour, ranges from 3.7c. down to 0.71c. in favorable circumstances. The average cost per engine-hour varies from \$1.11 to \$0.45, depending on the load factor and other conditions.

Further data of this nature were supplied by H. D. Hildebrand, in the discussion following the reading of the paper. Figures are based on 10 plants; five of which were operated by steam and five by gas engine; the average rated capacity of the 10 was 4500 hp.; units of 1300 hp. were generally adopted. Half of the plants were situated on railroads and the other half in remote districts. The average initial cost, including sites and dwellings, was \$56.33 per rated horsepower. The operating cost per rated horsepower-year included: Oils, grease, water, packing, etc., \$0.62; labor, \$1.95; repairs and upkeep, \$1.33; total, \$3.90, exclusive of fuel, which was gas, of which 23 cu. ft. was required per hp.-hour, costing $2\frac{1}{2}$ to 10c. per cubic foot.

PROFITABLE TO PUMP FROM LOW-PRESSURE WELLS.

The question is often raised as to whether it is profitable to pump gas when the intake pressure is below that of the atmosphere. This depends upon the size of the pool and the porosity of the rock; with a good-sized pool, and an open rock it is profitable to pump against even a high vacuum. In the Indiana field, some of the large compressing stations operated profitably for years with an intake pressure four or five pounds below atmosphere, while at some stations a vacuum of eight or nine pounds was not unusual. Operation under these conditions was strenuously opposed by the oil companies of the district. In the Pennsylvania and Kansas fields many pools are being pumped at rock pressures below one atmosphere.

Gas from the wells contains a quantity of vapor, oil vapor from the vicinity of an oil pool, or water vapor if from contact with salt water. Compression and cooling of the gas reduces its vapor carrying capacity, and oil or water is thereby deposited in the pipe lines. In a hilly country, these liquids are readily drained from the lines by suitable drips placed at low points, but in a flat country like Indiana the problem of keeping long pipe lines free from liquid is a serious one. During the period of greatest production in the Indiana

gas fields this task was successfully accomplished by first cooling the gas from the compressors in a large cooling pond, then conducting it slowly through large pipes, in order to give it time to drop most of its moisture. This cool and partially dry gas then passed through a dehydrating system, expanding ammonia still further reduced the temperature and more liquid was thrown down.

The idea was to reduce the gas to the lowest temperature while it was under the highest pressure, and the result was a practically dry gas for transportation.

As the Indiana natural gas was about 94 per cent. marsh gas, which liquefies at 2700 lb. per sq.in. and 12 deg. F., there was no danger of liquefying the gas under the dehydrating treatment. But this practice resulted in what was probably one of the earliest experiences in recovering gasoline from natural gas. For, in 1902, at one of the Indiana stations which was compressing gas from near an oil pool, we obtained from the drips of the cooling system an average of 80 bbl. of gasoline each day.

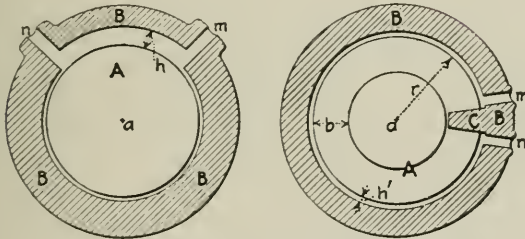


FIG. 1. DIAGRAM ILLUSTRATING PRINCIPLE OF GAEDE'S VACUUM PUMP

NOVEL AND EFFECTIVE HIGH VACUUM PUMP

A pump for economically producing the high degree of exhaustion needed for Roentgen-ray apparatus and for metal-filament lamps has been designed by Prof. W. Gaede, of Germany, employing radically new applications of apparently abstract scientific knowledge. The highest degree of vacuum yet recorded has been secured with this pump and in minimum time; yet there is a mechanically free and open passage from intake to exhaust of the machine.

The ideas involved were developed during experiments of the designer in the flow of gases through tubes. The earlier investigators had assumed that, with low pressures, gas

molecules were thrown back from the tube walls independently of the angle of incidence so that with a difference of pressure between the two ends (gas molecules heaped at one end more than at the other), as many molecules were thrown to the forward end as were thrown backward. Prof. Gaede found that this was true only for gas pressures below 0.001 mm. Above that figure, a gas film formed on the walls and the molecules were reflected preferentially normal to the wall irregularities which they hit—that is, back toward the direction from which they came. Because of this action of the gas film, the amount of gas flowing through a tube in unit times decreases and the friction between wall and gas increases. In computing the gas friction between moving surfaces it was found that pressure forces appeared which could be applied to the practical design of an air pump for high vacua.

The scheme is shown simplified in Fig. 1 and the application in Figs. 2 and 3. In Fig. 1, *A* is a cylinder rotatable about its axis and

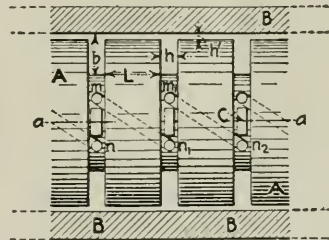


FIG. 2. ROTOR AND CASING OF THE GAEDE PUMP

inclosed within a casing *B*. In the casing there is milled out a groove extending from the port *n* to port *m* and having a depth *h*. If *A* rotates clockwise, the air in the groove will, owing to gas friction, be carried from *n* to *m*. The pressure difference between *n* and *m* is observable with a manometer and is proportional to the speed of rotation and the viscosity of the gas. On exhausting the casing, the pressure difference between *m* and *n* remains constant in spite of the resulting gas rarefaction because the viscosity is independent of the pressure. If the difference at atmospheric pressure is 760 mm. at *m* and 750 mm. at *n*, then on exhausting the air in the casing to 200 mm. at *m* a figure of 190 mm. is found at *n*. On further reduction to 50 mm. at *M*

there is a value of 40 mm. at n . If the pressure at m was reduced to 10 mm., then the pressure at n should be zero if the relation held and an absolute vacuum would be obtained. But the rule becomes invalid at such low pressures.

At the very lowest pressures, the ratio of the pressures at m and n is independent of the degree of exhaustion. At pressures below 0.001 mm. the gas film disappears and the gas molecules are diffusely reflected from the surfaces independently of the angle of incidence. The surface of the cylinder may be pictured as shooting out molecules from it in all directions with a certain definite velocity (the natural molecular velocity) depending on the gas. When the cylinder surface moves with a velocity greater than the molecular velocity, then in the groove h the molecules shot off from the cylinder in the direction n to m will have a velocity greater than twice the molecular velocity and no molecules at all can travel backward in the direction m to n . As a result, at n is a region impoverished of gas molecules—a vacuum. Thus while the pump is commercially valueless at atmospheric pressure, it gives notable results when used in conjunction with an auxiliary exhauster.

In the actual construction (Fig. 2) the cylinder A is given grooves of a depth b and a width h . The projection C attached to the casing B extends down into the groove. The general appearance of this type as made by F. Leybold's Successors, of Cologne, Germany, is shown in Fig. 3. The pump is belt-driven by a 1-3 hp. electric motor, but the belt drives a separate shaft to which the pump rotor is flexibly coupled so as to relieve the bearings. The pump works normally at 8000 r.p.m. The cylinder does not touch the casing at any point and the spindle is supported in the bearings by an oil ring. Nets are placed in the suction tubes to prevent the entrance of foreign bodies. Penetration of oil from the bearings into the exhausted casings is prevented by a special packing; for this to be operative, it is necessary, in starting up, to let the pump run up to speed and then to connect with the auxiliary pump. In stopping, the auxiliary must first be disconnected and then the main pump. All this can be done automatically by motor starters. A large pipe is provided for connection to the apparatus to be exhausted; the small nozzle is for connection to the auxiliary pump.

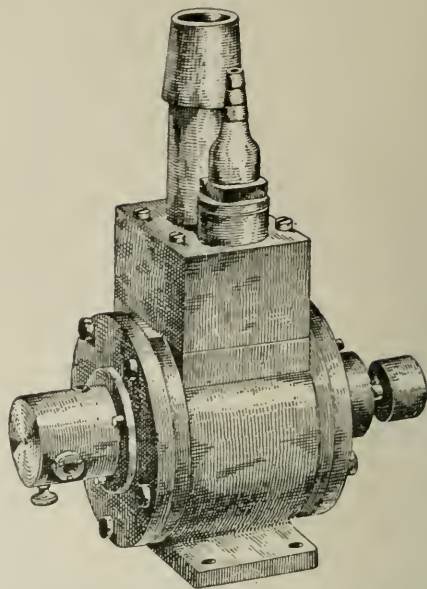


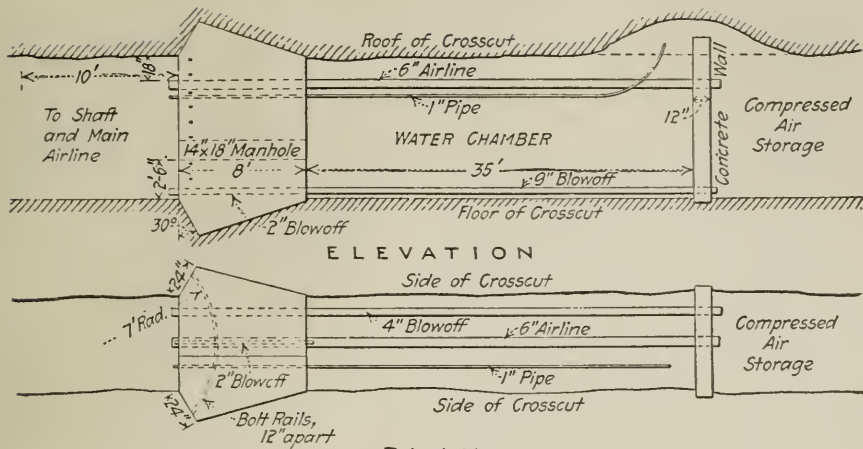
FIG. 3. THE GAEDE HIGH-VACUUM PUMP ASSEMBLED

Several machines of this type have been tested by the designer with average results shown in the following table.

R.p.m.	Mm. auxiliary exhaust.	Mm. final exhaust.
4,000	20.0	3.00
4,000	10.0	0.08
4,000	1.0	0.0003
4,000	0.1	0.00003
6,200	20.0	0.08
6,200	10.0	0.002
6,200	1.0	0.00005
6,200	0.1	0.00001
8,200	20.0	0.005
8,200	10.0	0.0005
8,200	1.0	0.00002
8,200	0.1	0.00000*

*Not readable.

Since the action of the pump depends upon the direct influencing of molecular motion, it was expected that the pump would not only draw off gases but vapors also, in contra-distinction to hitherto employed air pumps. This is confirmed in experiments which have shown that there was no need of employing phosphorus pentoxide or other drying agents, or of freezing out the vapors by immersing in cooling vessels filled with liquid air.



PLAN

FIG. 1

COMPRESSED AIR STORAGE IN ROCK

By FRANK RICHARDS.

One of the most familiar annoyances or inconveniences in the use of compressed air is insufficiency of storage capacity. In most of the employments of compressed air, especially in mining operations, the air is used intermittently and the rate of air consumption varies over a wide range. At the same time the usual air receiver is so small as to have little effect in maintaining constant pressure.

It has often been proposed and also many times attempted to use old and abandoned workings of mines for air-storage purposes, but in many cases complete failure has resulted on account of the impossibility of making the rock air-tight. It is, therefore, a pleasure to call attention to at least one instance where this scheme has worked successfully. The storage capacity in this case is a hundred times that of the largest commercial air receiver usually furnished.

Fig. 1 shows the essential features of a crosscut and drift on the 700-ft. level of the Center Star mine of the Consolidated Mining & Smelting Co., of Canada, Ltd., Rossland, B. C., which has been fitted up to serve as an underground receiver. In this case the rock was so close grained and free from fissures that the leakage was inappreciable. Fig. 2 is a plan of the workings appropriated for the receiver, the dam being placed as indicated. At this point the the rock was notched out so as to give a bearing at least two feet wide all



FIG. 2

around to take the thrust caused by the air pressure, which aggregated about 450 tons. The dam was made of concrete eight feet thick, reinforced as seen in Fig. 1, by nine horizontal arched rows of 30-lb. rails. A manhole, 14x18 in., was run through the middle of the dam and secured by a cover on the inner face.

Inside the dam, with a space of 35 ft. between, was erected a concrete wall 12 in. thick to form a water chamber between it and the dam. It will be observed that this wall had to resist only the water pressure of four or five pounds at the most, the air pressure being effective equally on both sides, communication being free over the top of the wall.

The air communication between the main

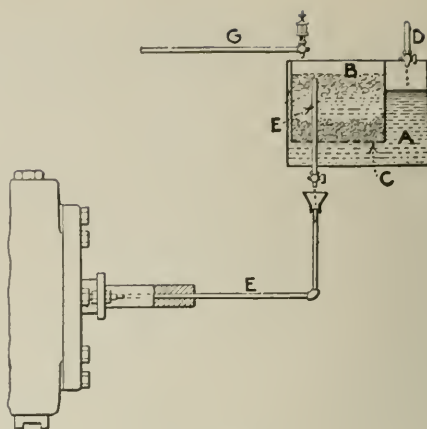
air line and the storage chamber was through the 6-in. pipe, this passing through the water chamber on the way. Any water which might accumulate in the bottom of the storage chamber could be drawn off through the 4-in. blow-off, while the 2-in. pipe would discharge the water from the water chamber when required. The function of the 1-in. pipe is not clear, but it could be used, like a try-cock on a steam boiler, to show whether or not the water was up to the turned-up head of the pipe.

How the water chamber was kept filled does not appear, but a pump must have been required for the purpose. It does not appear in fact how much the water scheme was used, Fig. 1 being from a blueprint made before the storage system was put into use. The air, so far as the storage function was concerned, was entirely independent of the water and we know that the storage is a permanent success. All necessary valves and gages were, of course, provided outside to keep the engineers fully informed and in full control. For the information embodied in this article I am indebted to George A. Ohren, of the Canadian-Ingersoll-Rand Co., Vancouver, British Columbia.—*Eng. and Min. Journal.*

SOAPSUDS LUBRICATOR FOR AIR COMPRESSOR

The cut is a sketch of a soapsuds feeder attached to a single stage air compressor as described by Martin McGerry in a recent issue of *Power*. The air is delivered at a pressure of 90 to 100 lbs. and the temperature therefore is high with the common result that carbonaceous material coats the valves and accumulates in the cylinder passages and in the receiver and pipes beyond. To overcome this trouble soapsuds have frequently been used as a lubricant with good results and descriptions of apparatus employed for the purpose are to be welcomed.

The lubricator consists of a small galvanized-iron water tank *A*, about 7x6x12 in. Inside of it a smaller one *B* is soldered to the large one with its bottom 2-in. above the bottom of the large tank. In the bottom of the small tank are a number of $\frac{1}{8}$ -holes at *C*. Soft brown soap, cut into small pieces, is put into tank *B*. Water is then fed into the large tank through a $\frac{1}{4}$ -in. pipe *D*, and passing through the small holes at *C* dissolves the soap and



SOAPSUDS FEEDER.

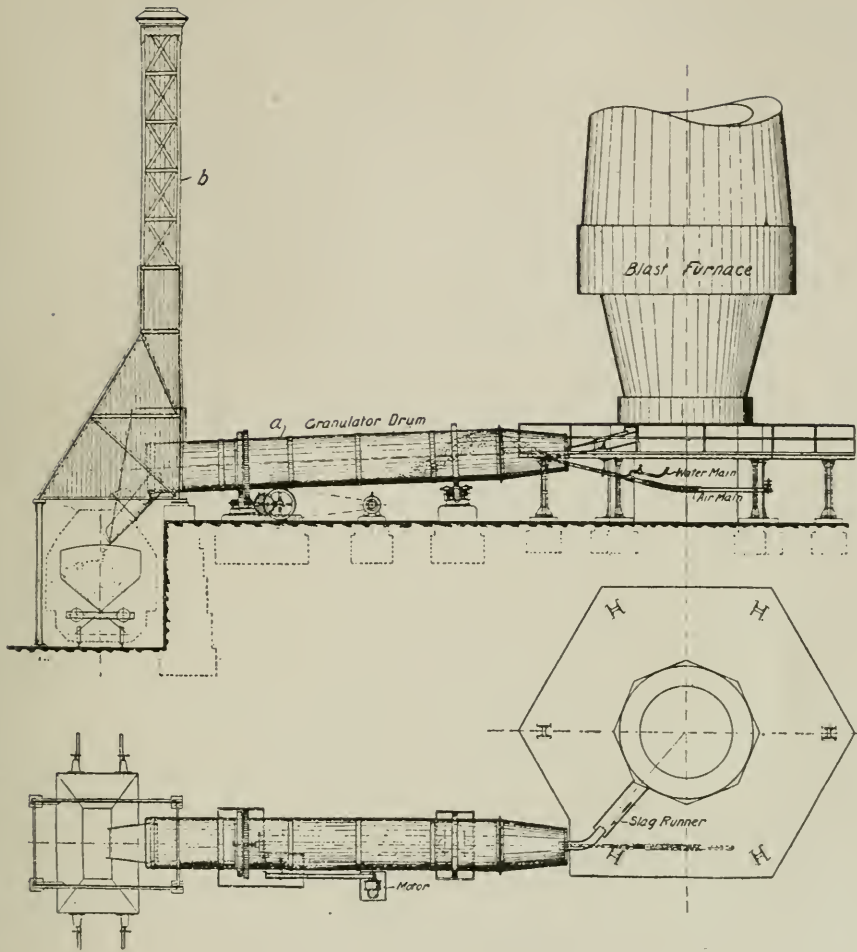
risers to the top of the $\frac{1}{4}$ -in. pipe *E*, through which it passes down into the inlet of the compressor. The water is regulated by the valve in pipe *D*, the small cock under the tank being left wide open.

Just before shutting down the compressor the water is turned off at *D*, and oil is fed into the small tank *B* from a cup *G*, and the compressor is run with oil for a half hour to prevent rust formation. Soap is used that will sink in the water; otherwise small chips will float and pass down through the pipe *E*. This lubricator is used on a 14x18-in. compressor, and when running at 150 r.p.m. with an air pressure of 90 lb., the water is fed at about 45 drops a minute.

AIR-GRANULATION OF MOLTEN SLAG

Blast-furnace slag granulated in a stream of cold water possesses hydraulic properties which are utilized in the manufacture of bricks and of cement. Granulated slag obtained from hot blast furnaces, contains up to 30 per cent. of water, and when used new, without being stored, as much as 40 per cent. of water. For the manufacture of cement it is necessary to completely remove this water by artificial drying, which process necessitates extensive drying plant and considerable outlay for fuel, repairs and labor.

Attempts have therefore for many years been made to discover a method of granulating slag by which the granulated product would be obtained dry and cool. In fact, a considerable number of apparatus have been proposed, some of which have been patented,



BUDERUS SLAG GRANULATING PLANT.

for producing such granulated slag. Such apparatus have operated either by directing by means of a nozzle a jet of steam or compressed air against a stream of molten slag, whereby the latter is broken up into a shower of small particles of slag, or by causing a stream of slag, as it flows from the furnace, to fall on to a rapidly revolving body, such as a disc or wheel, by which the slag is likewise thrown off in a granulated form. In both cases, the grains of slag are caused to impinge against stationary cooled walls. But notwithstanding that the walls are cooled, the slag adheres thereto, especially when large quantities are being dealt with continually, because the drops of slag are still so hot that they adhere

to the walls, where they form lumps which fall down as such when they become too heavy. The product consists therefore of unequally cooled slag, some of which is still red hot, varying in size from that of grains of sand to large lumps.

In the case of such apparatus only a partial air-granulation of the slag can be achieved because a portion of the slag, owing to this adhesion, has not been sufficiently chilled by the spraying process and therefore loses its hydraulic properties. An apparatus which is destined for the subsequent utilization of the slag for the manufacture of cement must therefore not only spray the slag, but it must provide continually cool and clean cooling

surfaces for the sprayed slag, on which each drop of slag is cooled individually and from which it is removed rapidly and automatically in order to allow the next drop to be likewise rapidly chilled; and by such a process alone can the hydraulic properties of the slag be preserved.

Acting on these lines, Mr. G. Jantzen, the works manager, has designed and erected a plant at the Buderus Iron Works, at Wetzlar, which is illustrated herewith. The slag channel from the blast furnace projects into an inclined rotating iron drum *a*. Beneath this there is a blast pipe terminating in a wide nozzle directed against the stream of molten slag flowing out of the channel. In this manner the slag is sprayed and immediately thrown against the shell of the rotary drum or propelled in the direction of its axis. The slag particles thus move over a large portion of the cooling surface of the drum, which can be cooled wholly or partly by spraying water on the outside, so that the slag is effectively cooled. Owing to the rotation of the drum, a fresh surface is constantly presented for the slag to impinge against. The slag in travelling through the drum, which is fitted with scoops, is continually turned over and exposed to the current of air, so that the slag particles, as they leave the drum, have the consistency of sand and are sufficiently cool for immediate removal by mechanical means. This sand does not contain any lumps or caked masses of slag, but consists of loose grains not exceeding the size of cherry-stones.

In the installation in question, the granulated slag sand falls directly from the revolving drum into the bucket elevator, which converts it into a storage bin, whence it is transported by an aerial railway to the cement works. But the sand might equally well be charged into railway trucks, as shown in the figure, preferably self-discharging trucks. The lower end of the revolving drum and the elevator pit are situated in an entirely covered space provided with a chimney *b* to carry away the fumes resulting from the granulating process, to a sufficient height to prevent them being a nuisance to the neighborhood. In order to prevent the formation of slag wool in the slag, means are provided for moistening, as required, the current of air used for spraying the slag.

The above-described installation for the air-

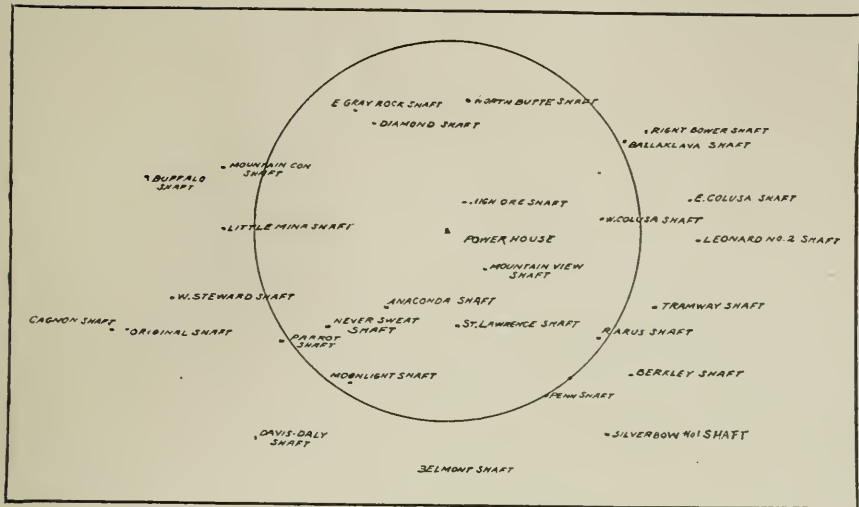
granulation of molten slag has been in continuous operation at the Sophienhütte Works of the Company for over a year, with a daily output of 100 tons of slag sand of the kind above described. With a drum of 72 in. diameter by 50 ft., the capacity depends only on the quantity and pressure of the current of air employed which has been taken so far from the blowing engine. However, since it is intended to apply air granulation to all the furnaces, the management have decided to install a separate turbo-blower, which will require about 10 h. p. to supply the present requirements of air for the furnace. The revolving drum and the bucket conveyor require about 8 to 9 h. p.

COMPRESSED AIR HOISTING AT BUTTE

BY THOMAS T. READ.

The substitution of compressed air for steam in operating the hoists at the numerous shafts of the Anaconda Copper Mining Co., at Butte Montana, is perhaps the most interesting event of recent years in power-plant engineering. The relative advantages of compressed air and electric power for this work have been vigorously discussed by mechanical and electrical engineers. But differential equations defining the relations of volumes, pressures, and temperatures are matters concerning which the average engineer knows little and cares less, and I propose in the following paragraphs to present merely a general description of this interesting and important power-plant, avoiding so far as possible all points of dispute, and hoping thereby to avoid being drawn into a controversy with which I have no concern.

The hoisting shafts of the Anaconda Copper Mining Co. are scattered over the hills north of the town of Butte, and are at elevations of 5600 to 6200 ft. above sea-level. The new central power-house is at an elevation of 6080 ft. The relative position of the different shafts is shown in Fig. 1, and the circle, drawn with a radius of $\frac{1}{2}$ mile and with the new power-house as a centre, serves to indicate the distances involved. At these shafts steam-driven hoists, rated at 3000 hp., and hoisting 5-ton skip-loads of ore at the rate of 2800 ft. per minute, have been in operation. Each shaft is also provided with a smaller hoist, locally known as a "chippy," for handling timber and general supplies for work under-



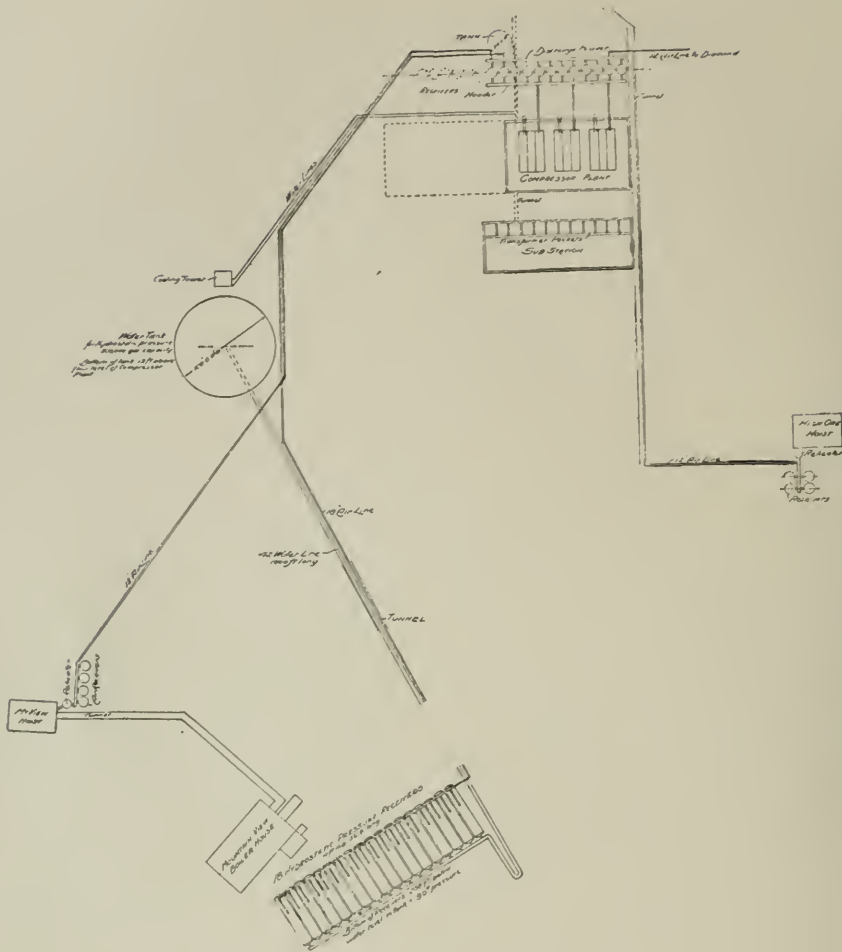
DISTRIBUTION OF MINE SHAFTS AT BUTTE.

ground. Hoists are operated on both shifts, the actual time which the main hoist is in motion being, according to B. V. Nordberg, about 5 hours out of the 24. Each shaft was provided with a boiler-plant, with its necessary labor, and coal, costing \$4.50 per ton, was distributed to the shafts. The advantages of operation from a central power-station which could counterbalance the fluctuations in the power requirements of the individual hoists is evident. The recent growth of hydro-electric power development in Montana has made available at the mines an ample supply of electric energy, generated at the plant of the Great Falls Power Co., near the town of that name, on the Missouri river. This is transmitted 130 miles from Great Falls to Butte, at 100,000 volts, and is transformed to 2400 volts for use at the mines. The cost of electric power is \$35 per horse-power-year, and when the full supply of electric energy became available about two years ago, it was at once decided to use it in place of coal, as a source of power supply. The question remaining to be decided was what medium of transmission of this energy could be employed to the greatest advantage.

Several methods of doing this were feasible. Electric hoists might have been placed at the shafts, this making the Great Falls plant the central station. But so simple an arrangement as this would have caused fluctuations in the power transmitted through the long transmis-

sion line that would have resulted in peak-loads of prohibitive magnitude, and to equalize the consumption of electric power some form of compensating device would therefore have been necessary. Storage batteries are not satisfactory for mine work; the loss of energy in converting electric energy into chemical energy and the latter to electric energy again, the cost of construction and maintenance, and their constant deterioration has led to a discontinuance of their use for this kind of work. The Ilgner transformer has given good results in Germany and elsewhere when employed for hoists which are in nearly continuous operation, but cannot be utilized to advantage on hoists which are idle a large part of the time. It was therefore decided to use the electric energy to drive air-compressors at the central station, the air being stored in a system of receivers and air-lines which distribute it to the hoists. It is then reheated and used in the rebuilt cylinders of the old steam-hoists. I will first describe the power-plant, as its advantages can then more easily be indicated. The plant is still under construction, but for the sake of clearness and convenience I will describe it in the form it will have when the construction work now under way is completed.

The electric energy from Great Falls is delivered at the transformer house, seen in Fig. 2, and transformed to 2400 volts. Six Westinghouse A. C. synchronous motors, of 1200



PLAN OF COMPRESSED AIR INSTALLATION.

hp. each, drive 6 Nordberg cross-compound air-compressors having 30 and 50-in. diameter cylinders, each compressor being rated at 7500 cu. ft. per minute. Three of these compressors are fitted with variable-capacity valve-gear and the other three are of uniform capacity. The air is compressed to 23 lb. in the low-pressure cylinder, passes through the inter-cooler, and is compressed to 90 lb. This pressure was chosen so that any excess air above the requirements of the hoists can escape through a safety-valve into the mine system and be used to supply the rock-drills, thus relieving the compressors now used for that purpose. The load on the motors is thus kept ab-

solutely uniform during the 24 hours of the day. The method of supplying air for excessive demands will be described in a moment. In starting an air-compressor air is introduced from the receivers for that purpose, so that one may be started and another stopped without causing any variation in the electric power-load. It is expected that five compressors will serve to meet all the ordinary requirements of work. Since construction work was started, the daily output of the mines has been increased from 12,000 to 15,000 tons per day; the load on the power-house is therefore somewhat dependent upon the market price of copper.

The air from the compressors is delivered to

a battery of 18 vertical cylindrical receivers 10 by 30 ft. and of a capacity of 360,000 cu. ft. of free air, when compressed to 90 lb. As these receivers are 50 or 60 ft. distant from the compressors a small receiver is placed above each high-pressure cylinder. These receivers are connected by air-lines with the receivers placed at the hoists; four receivers of the same size as those just mentioned being placed at each hoist. They are also connected with the storage equilibrium system, seen in Fig. 2, which is an essential feature of the design. The receivers just mentioned are connected by an 18-in. air-line with 16 horizontal receivers, each 10 ft. in diameter, and 56 ft. 8 in. long, placed on the hillside a short distance above the Leonard shaft. These receivers are connected by a 42-in. water-line (having a 25-foot loop at the bottom for safety) with a 500,000 gal. water-tank on top of the hill a short distance south of the power house. When the water in the tank is $8\frac{1}{2}$ ft. deep it stands 208 feet above the receivers, thus giving a pressure of 90 lb. per square inch. When the air consumption by the hoists exceeds the supply from the compressors the water flows down into the lower receivers, displacing the 66,840 cu. ft. of compressed air which they contain (equivalent to 568,000 cu. ft. of free air). This storage system not only serves as an equalizer of the load upon the central power-house, but in the event of the total failure of the electric power, the stored air will serve to operate each hoist for twenty minutes, thus making it possible to hoist out the men at work underground. It should be noted that this reserve remains available indefinitely until it is used up; whereas with an Ilgner transformer it would be necessary to utilize the power of the transformer at once, perhaps before it would be possible to collect all the men at the stations.

Four air receivers are provided at each hoist. The air on its way to the hoist passes through a sectional surface heater of special design, 50-in. diameter and 25 ft. high. The heat is furnished by a 50-hp. return tubular boiler, giving steam at 200 lb. pressure and serving to reheat the air to 300 degrees F. The coal used for reheating the air amounts to 1-3 lb. per horse-power hour. As the steam hoisting engines were operated at from 120 to 150 lb. steam pressure and the air is at 90 lb. the hoists have been altered by removing the old steam cylinders and replacing them with larg-

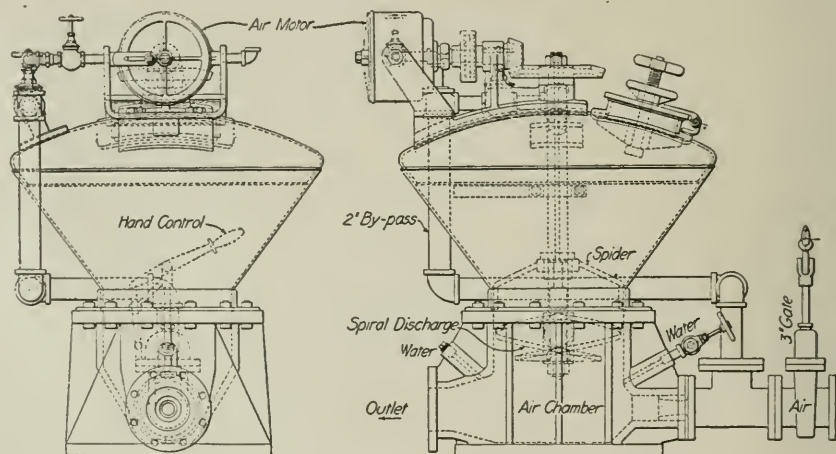
er ones, this being the only change necessary. The valve-gearing of these cylinders is so constructed that the full power can be turned on to secure the necessary acceleration, and when the skip begins to approach the top the speed of engine is checked by compressing air in the cylinders, which is accomplished by means of a compression lever operated by the engineer and by which means the exhaust valves are made to cut off at any desired part of the stroke, thus compressing the air in the cylinders and delivering it back into the main system. The speed of engine can also be checked by reversing the valve gear and compressing air in the cylinders, which is drawn in through the exhaust pipe and delivered into the main system as before. The energy which would ordinarily be wasted in useless friction on the brake shoes is thus returned to the storage system to be utilized on the next trip. The valve mechanism required for this purpose is extremely simple, and the hoist men are stated to prefer to operate the air hoists rather than the steam-driven ones.

It will be noted that this system required the minimum amount of change in the present equipment. In the steam hoists, many of them of the flat-rope type and large enough to operate to a considerably increased depth, no further changes were necessary than the replacing of the cylinders. If electric hoists had been employed it would not only have been necessary to discard the steam hoists, but the surface plant would have required reconstruction, since the floor space required for an electric hoist greatly exceeds that of a flat-rope hoist.

Many of the advantages of the compressed air system in meeting the governing conditions at Butte are evident from the description. It must not rashly be inferred that compressed air, like a patent medicine, is good for all hoisting troubles. In this case, however, where a large number of hoists are to be operated from a central power plant, compressed air forms a useful means of power transmission because it is elastic and can be stored. In this way the occurrence of high peak loads can be automatically and mechanically prevented. This is aided, of course, by arranging the regular hours for hoisting at the various shafts so as to distribute it throughout the day, as far as possible. The hoists at the Mountain View, Diamond, High Ore, West Gray Rock, Leonard, Tramway, and Pennsylvania shafts have already been converted to the use of

compressed air and 7000 tons per day is now being hoisted by the compressed-air hoists. The other hoists will be converted one at a time, as it is necessary to interfere as little as possible with the regular output of ore. The theoretical efficiency of the plant is stated as follows: motor efficiency, 95 per cent.; mechanical efficiency of compressors, 90 per cent.; efficiency of air compression, 83 per cent.; efficiency of hoist, 50 per cent.; total efficiency without reheating, 35.48 per cent.; efficiency after reheating, 53 per cent. Thus 1.88 hp. of the compressor motor is equivalent to 1 hp. at the hoist. In closing I wish to express my obligation to John Gillie, C. W. Goodale, B. H. Dunshee, and W. J. Lilly for the facilities which they so kindly accorded for observation of the plant and securing data regarding it.—*Mining and Scientific Press*, San Francisco.

of these materials in the drum. The air is admitted through a hand-controlled valve to a flanged pipe leading directly to the air chamber. A 2-in. by-pass leading to the air motor is placed in this pipe in front of the air chamber. In this way the operation of the machine starts simultaneously with the admission of air to the line. Globe valves are placed on this by-pass line to permit of proper control of the pressure. Water is admitted through two connections at the front and the back of the air chamber. The front connection is used for grouting purposes and the back one for mixing the concrete. The pressure at the compressor is 85 lb. per square inch, but the entrance valve is choked down to reduce the pressure to less than 60 lb. at the chamber. The concreting materials are spread in alternate layers of stone, cement and sand and shoveled directly

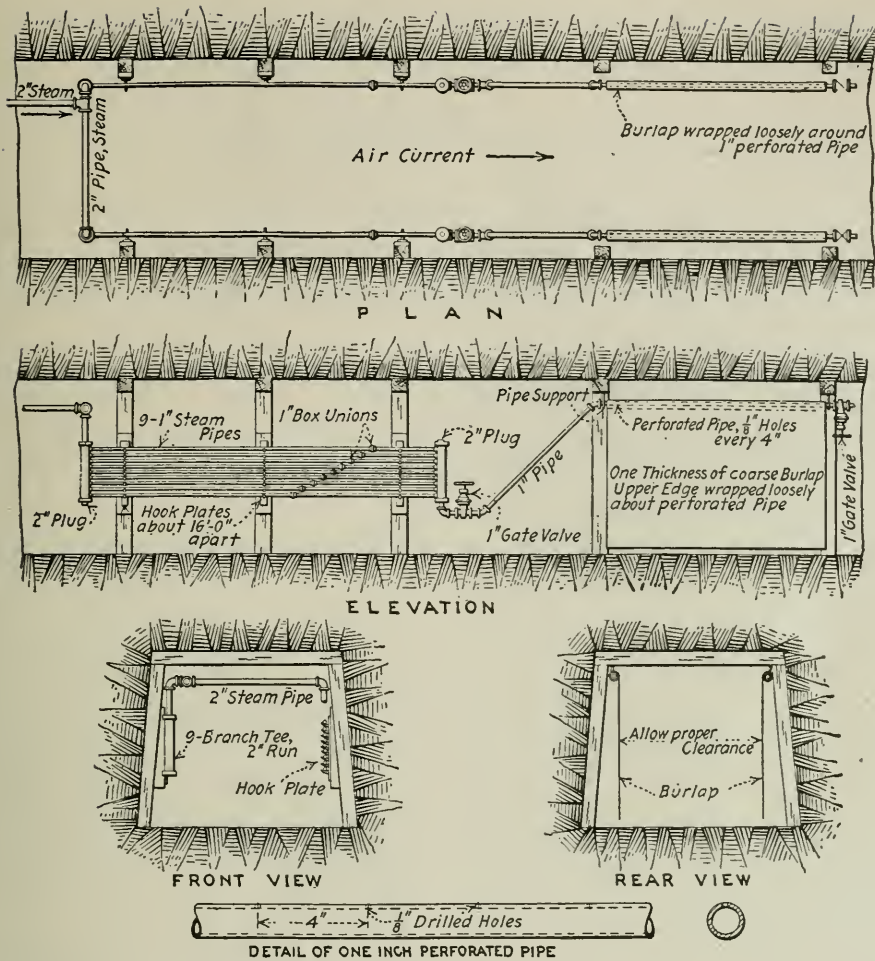


NEW TYPE OF CONCRETE BLOWER

A machine for distributing concrete by compressed air has recently been perfected by W. Van R. Whitall, Inc., New York City. The blower, the main features of which are shown in the accompanying drawing, comprises essentially a steel drum or receiving hopper bolted to a cast steel discharging chamber. A central shaft passes through the drum to a spider at the bottom, below which is a spiral discharge into the air chamber. This shaft is connected through bevel gears to an Ingersoll-Rand four-piston air motor. On the top of the drum is an opening, fitted with a hinged cover, through which the materials are admitted. A steel bar with knife edges is bolted to the shaft and, rotating with it, prevents possible arching

into the drum. As they pass from the latter into the air chamber the water spray is encountered and the combination of air pressure and water results in a thorough mixing of the materials.

One of these machines, with a capacity of 3 cu. ft. has been used in building a 4x5-ft. concrete drain for the city aqueduct of the New York Board of Water Supply. The machine was placed at the bottom of the shaft 42 ft. from the surface and charged from the top through wooden chutes. About 300 cu. yd. of 1:2:4 concrete have been thus placed. Under these conditions about 3 minutes were required for charging and 45 seconds for shooting the concrete through 125 ft. of 5-in. pipe to the forms.



PRACTICAL HUMIDIFICATION OF MINE AIR

B. J. Matteson, assistant manager of the Colorado Fuel & Iron Co., in his remarks before the Rocky Mountain Coal Mining Institute, gave the following description of a method of humidifying mine air which has been used with marked success in the mines of his company.

A radiator is placed on both sides of a heading through which the entering air passes. Its construction is clearly shown by the accompanying drawing. Live steam is passed through it and the waste steam which is discharged is conducted to a perforated pipe through the 1-in. gate valve shown on the drawing.

Attached to this perforated pipe is a cur-

tain of burlap or brattice cloth, the purpose of which is to bring the moisture or condensed steam in contact with the air current. As the air passes over the radiator it is heated and its capacity to pick up moisture correspondingly increased.

It then passes over the saturated curtains and its humidity is raised to the dew point. The air usually reaches the inby end of the cloth screen at a temperature of approximately 70 deg. F., and as the air current passes through the mine, a deposit of moisture is secured by the lowering of the temperature of the air to that of the mine.

The operation of the radiators has been very successful and has enabled us to keep all parts of the workings in a moist condition. In Col-

orado, the relative humidity of the atmosphere in the winter time does not average above 15 per cent. and much water must be furnished the air or it will dry up the mine in its passage.

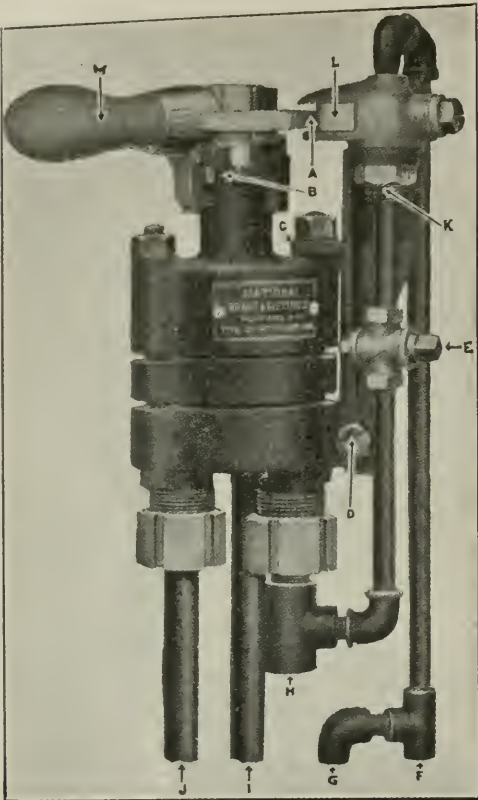


FIG. 1.

THE JOHNSON AIR-BRAKE SYSTEM

In line with the modern tendency in electric railway operation to eliminate the human element as far as possible, Mr. Oscar Johnson, of Chicago, has devised a system which should be an inestimable aid to the motorman in cases of emergency. By means of this system the motorman is able to perform four distinct acts at one operation, namely, ring the gong, sand the rails, turn off the power and apply the brakes. There is consequently no possibility for him to become confused and do the wrong thing. The Johnson system, moreover, insures the performance of these various necessary acts in their proper rotation. For instance, should the motorman fail to turn off the power in advance of operating the brake-handle, the

device will do it for him automatically. Sand is also applied at the proper time, thereby increasing the braking power and preventing the slipping of wheels, as the sand is applied to the rail before the brake takes effect. If the brakes are applied without the use of sand and the wheels are sliding, the sand cannot be dropped under the wheels and the brake must be released before the sand can be applied. Sand being applied under these conditions makes it impossible for wheels to become flattened. With this system the conductor also is able to perform, at his end of the car, all of the functions of the motorman in case the latter should lose his head or become disabled.

Fig. 1 is an assembled view of the parts to the motorman's valve shown as operating in an emergency position. A indicates the cam of the handle M entered into the supplementary valve as indicated at L which simultane-

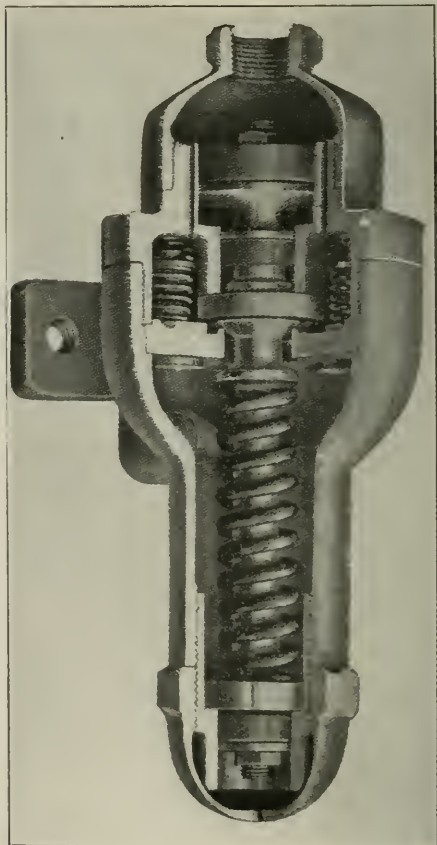


FIG. 2.

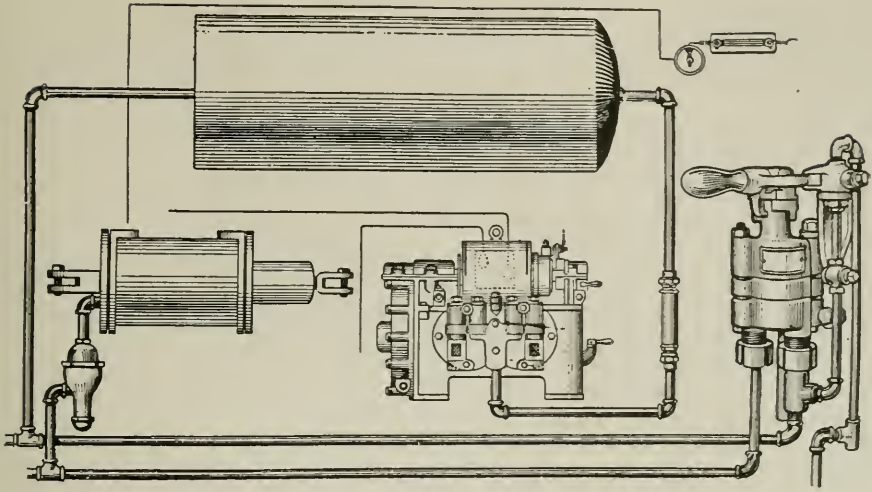


FIG. 3.

ously rings the gong and deposits sand on the rail in advance of applying the brake indicated at *B*. In the ordinary operating position, the handle is quarter turned so that the cam is disengaged from the supplementary valve. The bracket is shown attached to the motorman's valve at *C* and *D*. A stopcock indicated at *E* is provided for in the supplementary air line, which branches off to the gong and sand, as indicated by *F* and *G*, also shown in Fig. 4 at *R*. The supplementary valve is fastened in the bracket and the pipe line thereto as indicated at *K*. The main reservoir pressure enters into the motorman's brake-valve at *H*. The ordinary exhaust-pipe is indicated by *I* and the train line by *J*.

Fig. 2 shows an especially designed reducing valve for creating a uniform pressure to the brake cylinder. Oft times the governor varies between minimum and maximum pressure

from 20 to 25 lbs. Figuring on an 8-in. brake cylinder, in general use on electric railways, would mean a difference in braking pressure of 1,000 to 1,500 lbs. on the piston. This valve can be set at whatever brake leverage is figured at and maintained. The valve is especially useful where trail cars of a lighter weight are used, as the valve can be set for the trailer for 30 or 40 lbs., and the motor car be braking at 60 or 70 lbs., or whatever the valve may be set for, according to the weight of the car. Where straight air is used for trailer service, with the system now in ordinary use, the light car would receive the same pressure as the heavy car, giving an excessive strain on the trail car brake rigging. This valve is simple in construction and is not sensitive to the foreign matter with which the air used in the air-brake system on street railway cars is generally charged.

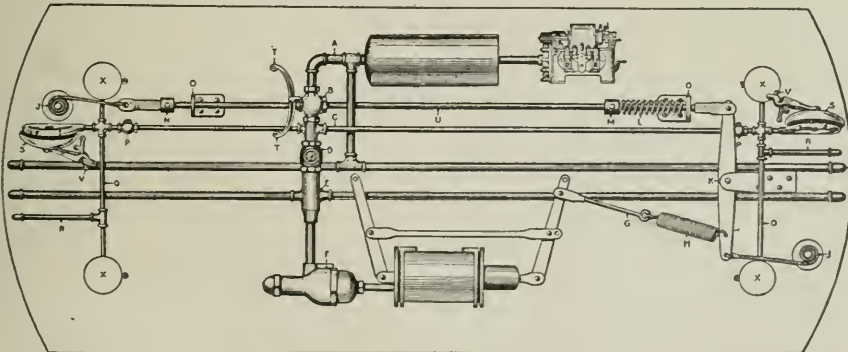


FIG. 4.

Another advantage claimed for this reducing valve is that it can be placed close to the brake-cylinder where it will register quickly and not be subjected to constant pressure. The use of this valve, it is claimed, also overcomes, to a large degree, the variation in air-governor pressure while the braking pressure remains at the pressure at which the leverage is figured.

Fig. 3 shows the air system from where the air is compressed to where it is utilized as well as the simplicity of the apparatus.

Fig. 4 shows how the conductor has the same control of the car as the motorman, as indicated in the pipe line from *A* to *F*. It will also be seen how the valve *B* can be operated from either end of the car by a cord attached to a lever *T*, which causes the air to flow through the pipe line *C* to the gong *S* and to the sand-boxes *X*, through the valve *E*, which shuts off the train line and continues through the bypass in through the reducing valve *F*, thence into the brake cylinder, thereby causing the brake to apply. When the brake is applied this causes the operation of an additional fulcrum arm *K* by means of connections indicated by rods *G* and *H*. The movement of the fulcrum arm unwinds the controller shaft *J*, thus turning off the power. A spring is employed to bring the fulcrum arm back to its normal position as indicated at *L*. The rod connected to the fulcrum arm operating the other end of the car is indicated at *U*. Check valves *P* are provided for the purpose of preventing the gong and sand from being operated on the rear end of the car when the motorman is operating the car from the front end. The usual means provided to sound the gong is indicated at *V*.—*Electric Traction*.

BOILING POINTS OF METALS

The boiling points of various metals have been determined by H. C. Greenwood, by means of an optical pyrometer, at the time when vaporization became sufficiently vigorous to project drops of metal from the surface. These boiling points (Centigrade) at atmospheric pressure are as follows: Antimony, 1420; Bismuth, 1440; Lead, 1525; Aluminum, 1800; Manganese 1900; Silver, 1955; Chromium, 2200; Tin, 2275; Copper, 2310; Iron, 2450.

THE PNEUMATIC HAMMER

You can hear my sharp staccato as I play an obligato

On the girders of a structure that is forty stories high,

While the crowd below is gawking at the iron workers walking

On a slender swaying "I" beam sort of tethered to the sky;

They're the song and I'm the chorus, and we have our job before us

As we tie the steel together with the rivets red and hot,

And the sparks they hiss and spatter as I clatter, clatter, clatter!

For I like to have it noticed that I'm Johnny on the Spot!

Then I'm numbered with the toilers who are turning out the boilers

And you'll find my masterpieces on the land and on the sea,

Keeping railroad trains in motion, driving liners on the ocean,

Or supplying the compressors with the force they give to ME!

Set a task, I sure attack it with the maximum of racket,

I'm no shy retiring worker. I am talkative and loud,

And I batter and I chatter as the sparks go spatter, spatter

And I love the busy city and the noises and the crowd!

Where they build the ships for battle you can hear my airy prattle

As I hammer on the framework of the warriors of the deep,

And where bridges span the river I can keep your nerves a-quiver

With my everlasting clamor which would never let you sleep.

I'm the young tradition shaker. I'm the blatant empire maker

I'm the prophet of to-morrow and the builder of to-day,

Sloth and ancient doubt I shatter as I clatter, clatter, clatter

In a song of hope and progress and a yell of "clear the way!"

Berton Bracey in Technical World.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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MAKING GOOD

The present is the age of mechanical appliances intended to replace the labor of man. Formerly the principal reason for using machinery instead of human hands was because of the greater productive capacity of the power-driven apparatus, and this is still the natural incentive to devise so-called labor-saving machinery. With the developing use of mechanical devices for doing work, however, there have appeared a number of other reasons for their extending use, reasons which, when followed to their legitimate conclusions, cannot fail to have an important influence upon methods of administration and management.

Thus it is well understood that heavy and brutalizing labor, such as lifting heavy burdens, violent exertion under exposure to high heat, as in stoking boilers or operating metallurgical furnaces, drilling and cutting rock in different positions, and similar heavy physical labor, is well replaced by mechanical appliances, even if no other advantage resulted. The men who formerly did such work are far better employed in guiding and directing the power-driven machinery than in straining their muscles beyond reasonable limits.

Again, in the development of repetitive processes the machine relieves the man from the continual and monotonous operations which fatigue the hand and make little or no demand upon the mind, setting the operator free to control and manage a number of tools, upon which he directs his head, using his hands in a reasonable and legitimate manner.

These are but a few examples of the manner in which the engineer is raising the position of the workman from that of a machine himself to that of a director of machinery, and to this industrial development much of the progress of the world to-day is due.

When, however, a machine is so designed as to take the place of a man, or of many men, the inanimate apparatus itself is also placed upon a different plane, and partakes, so to speak, of a portion of the responsibility of the individuals which it replaces. If a man failed to do his work properly, he was held responsible for the consequences, and the rank and position of the skilled workman depended very largely upon his record and reputation. This is still the case, in an increasing degree, of the man; but it has also been largely placed

upon the machine, so that apparatus made by builders of high reputation partakes of the standing of the firms by whom it is built. As a natural consequence of this responsibility, the reputation of the manufacturer is dependent upon the performance of machinery bearing his name, thus builder and tool have a status to be maintained.

Nearly every man who has built up a reputation for himself and his work has done so by actual performance, by "making good," and when any question arises as to his capacity for any undertaking placed in his hands he is able to produce his credentials and stand upon his record.

The machine which, to a large extent, is taking the place of the man, must also be able to produce its credentials and show its record; and when this can be done it is placed in much the same position as the skilled workman who has his past work to witness to his ability and capacity. The new machine is in like manner comparable to the new man; it may be most excellent, even better than the equipment which has been in use for years, but it has its record to make and its credentials yet to acquire.

Thus, while methods and devices change, the fundamental principles beneath them reappear in forms which may readily be perceived by the observant engineer and manufacturer, guiding him and aiding him in attaining best results by enabling him to bring to his service both men and apparatus of the highest class.

STILL A BIG SUPPLY OF NITRATES

In our September issue readers were editorially urged not to worry about the atmosphere because of the abstraction from it of a little nitrogen for the manufacture of fertilizers. Now comes William S. Myers, official delegate of the Chilean government to the International Congress of Applied Chemistry, and head of the Nitrate Propaganda in this country, who assures us that the current statements regarding the exhaustion of the world's supply of nitrogen are uncalled for. He says:

First of all, there is a vast amount of unsurveyed nitrate ground on the Chilean pampas that is known to contain immense quantities of nitrate of soda. Second, grounds already surveyed still contain enormous quantities of nitrate. There are probably in round

numbers, 1,000,000,000 tons of nitrate in the deposits of Chile, and, without doubt, large supplies also exist on lands now but incompletely prospected. The surveyed and certified tonnage opened up at the present time ready for extracting is fully 250,000,000 tons.

The probable life of the surveyed deposits is at least 400 years, even allowing for a steadily increasing annual rate of consumption. Moreover, there remains the interesting question as to whether by the end of the ensuing century we may not find that nature has manufactured an immense additional amount of Chilean nitrate for the uses of the world.

Sir William Crookes' prophecy that the world would starve as soon as the Chilean nitrate supplies were exhausted has for some years led the chemical public to believe that a wheat famine was in sight, but that time is so far distant that no one living to-day need have misgivings on the subject.

NEGLIGENT COMPRESSED AIR PRACTICE

At a meeting of mining engineers recently held at Edinburgh Mr. Sam. Mavor spoke of compressed air in British coal mines as follows:

I am at present conducting an investigation into the use of compressed air in underground work, and in the course of this investigation some surprising results have emerged. Your compressed-air pumps, compressed-air haulages, and compressed-air coal-cutters, are nearly all inefficient, not only absolutely inefficient, but inefficient relatively to the efficiency which might be obtained from this class of plant. The ultimate responsibility for this state of affairs rests upon the manager. In the course of the investigation to which I refer it has emerged that not unusually the proportion of leakage of compressed air is from 20 to 30 per cent. of the total amount of the air compressed. In some cases the proportion of loss by leakage has been considerably over 30 per cent. of the total volume of air compressed. Many managers have been reluctant to believe that they are doing so badly, but if there is any colliery manager who is using compressed air for general power service underground who thinks he is obtaining any such efficiency as 20 per cent. I am quite prepared, at his own colliery to demonstrate his error.

There is no other type of plant so liable to

deteriorate in respect of efficiency as that operated by compressed air. If there is plenty of power on the surface, underground losses develop and increase, but so long as the required work is done somehow, the losses do not bite anybody, and they pass unnoticed. In the days of underground steam pipes, when leaky steam joints made a roadway intolerable, the joints were repaired, but with compressed air there is no such compelling inconvenience.

One of the last things one finds underground is a pressure gauge, yet no instrument is more easily applied, nor could any provide a more direct and emphatic check upon one of the principal sources of low efficiency of the compressed-air system. It is a simple and almost incredible fact that at the majority of collieries where compressed air is used a pressure gauge is never seen underground. This is true not only of small collieries, but of many large ones. It is not unusual, on the contrary it is quite usual, to find that half the total pressure to which the air is compressed is lost in the trailing hose, valves, and piping in the immediate neighbourhood of coal-cutters. Immense sacrifice of efficiency in compressed-air coal-cutters is due to hose, valves, and branch piping being much smaller than they ought to be. Low efficiency here involves not only loss of power, but inefficient use of labour, because two shifts of men are often required to cut a distance that with proper appliances could be cut in a single shift. No one who has not had opportunities of investigating present-day conditions as to the use of compressed air, has any conception of the extent of the general preventable extravagance of power and labour resulting from lack of competent supervision of in-by details.

COMPRESSED AIR AUTO STARTERS

The following we condense from a recent issue of *Internal Combustion Engineering*, London.

The time is rapidly approaching when every car will have some kind of self-starting apparatus installed as a standard fitting, the buying public are demanding it, and designers ought therefore to consider which of the many systems they will have. Though the use of compressed air is regarded by some as inferior to other systems, it is undoubtedly as effective in starting the motor, and has the advantage of being of use for other pur-

poses than that for which it is primarily installed.

The most favoured installation comprises the following: An air pump, or compressor; a cylindrical steel tank for storing the compressed air; a distributor for passing the air to the engine cylinders in proper sequence, and a starting valve, situated in a handy position for the driver. The pressure to which the air is to be pumped and maintained is first decided, and this is governed largely by the size of tank it is permissible or desirable to carry. The usual practice is a tank of about 800 to 1,000 cubic inches capacity, with an air pressure of from 300 to 400 pounds per square inch. This pressure is, of course, much in excess of that actually necessary to start the motor, especially if it be a six-cylinder, 100 pounds per square inch being in most cases ample; but, as above implied, if a lower pressure were used a larger tank would have to be carried. A lower pressure is to be recommended, as it has three points of advantage at least over the high, namely:—

It is not so likely to blow the joints and connections.

The pressure on the pump bearings and distributor disc (where this type of distributor is used) is reduced, and consequently the wear also.

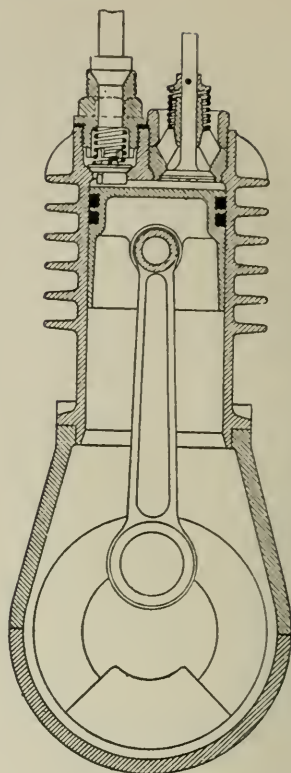
Upon the compressed air entering the engine cylinders it expands, and consequently its temperature drops very rapidly. The higher the pressure of the air entering the cylinder, the lower will be its final temperature after expansion, and the greater its chilling effect on the interior of the cylinder.

This last is considered by some to have a detrimental effect upon the motor, and although it is of little consequence when the motor is started from cold, it certainly is undesirable in cases where the engine is stopped and started frequently during a run, as the first gas charge entering the cylinder encounters the chilled cylinder walls, and in all probability some few gas charges pass through the cylinders before an explosion takes place. The effect of this chilling, of course, vanishes as soon as an explosion has taken place and the motor is running on its own fuel.

The air pressure having been decided upon, the design for the various components can be made out. It is rather surprising to note here that those manufacturers who have al-

ready fitted a starting system similar to that here described, have almost invariably distributed it over the entire chassis, and the control (in the case of those systems which provide means for cutting out the air pump when the pressure in the tank is attained) and piping arrangements have consequently been complicated, heavy and expensive. In some cases both the air pump and the distributor have been situated on the engine, the pump being driven from the camshaft direct, while the distributor is usually driven by skew gears from the camshaft situated about the centre or the opposite end of the engine. Others have taken the drive for the compressor from the clutch shaft, thus necessitating its attachment to either the side member of the chassis frame or the gearbox. In this case the distributor usually takes its drive from the front end of the camshaft direct. In designing a starter of this type to suit an existing car, these arrangements could not easily be avoided, but in cases where the starter has been designed with the car, it is difficult to see why these arrangements have been adopted.

Considering first the compressor it is certainly desirable to arrange that it shall be thrown out of operation as soon as the desired pressure of air in the reservoir is reached. Some designs provide means whereby the compressor, when the final pressure is reached, no longer delivers air to the reservoir, but expels its charge into the atmosphere again, the inlet valve being held open, usually mechanically. Another method is to have the clearance space at the end of the cylinder such that, with the valves closed and a charge of air compressed with the piston at the end of its stroke, the pressure inside the cylinder shall be equal to the final pressure in the reservoir. In this case, when the pressure is attained in the reservoir, the pressures on each side of the delivery valve are equal, and consequently it will not open until the pressure in the reservoir drops, and the air in the cylinder is undergoing compression and expansion alternately. The first method is likely to be noisy, and both are adding greatly to the wear. So that, as it is exceedingly desirable that the piston and rings, at any rate, remain tight for as long a period as possible, it is evident that it is well worth while to provide means for cutting out the compres-



AIR COMPRESSOR FOR AUTO.

sor altogether, especially as it can be done at little cost.

A typical design of compressor is shown in the cut, and needs no description. The usual size is about $1\frac{3}{4}$ in. bore by $1\frac{3}{4}$ in. stroke, two rings on the piston have proved satisfactory, the valves, inlet and delivery are usually in the head of the cylinder and of fair size, the inlet valve for a pump of the above size being about $\frac{11}{16}$ in. outside diameter. In a few instances the inlet valve has been replaced by holes drilled through the cylinder wall in such a position that the piston uncovers them when nearing the bottom end of its stroke, thereby admitting the fresh charge. When determining the clearance volume of one of these pumps it must be remembered that their efficiency is very low, seldom exceeding 45 per cent. Heat losses, losses due to leakage, and incomplete cylinder filling account for this. It seems that the heat losses are likely to remain, as it is universal practice up to the present to rely on air cooling, and it is

a question as to whether anything else is worth considering in this case. Leakage, of course, depends greatly on workmanship, and with this type of starting system workmanship is of great importance all through.

Now we come to incomplete cylinder filling, or volumetric efficiency, and this accounts for over 30 per cent. of the total losses; the automatic inlet valve is to blame for this to a large extent, as it sets the limit to the initial pressure in the cylinder before compression takes place.

Take for example a pump of the size mentioned above, $1\frac{3}{4}$ in. by $1\frac{3}{4}$ in. Inlet valve $\frac{1}{16}$ in. outside diameter, spring pressure 1 lb. Delivery valve $\frac{9}{16}$ in. outside diameter, spring pressure 1 lb. Clearance volume $5\frac{1}{2}$ per cent. of the total volume of the cylinder.

The volume swept by the piston is 4.2 cubic inches. Clearance volume equals .245 cubic inches. Taking the formula for the compression of air, Adiabatic,

$$(V)^{1.41} \times A = \text{Terminal pressure.}$$

$$(v)$$

Where V = total volume, v = clearance volume, and A is atmospheric pressure, about 14.7 lbs., we have:

$$\left(\frac{4.445}{.245}\right)^{1.41} \times 14.7 = 886 \text{ lbs.}$$

A compressor of approximately the above dimensions gave a pressure in the reservoir of 350 lbs., so that the efficiency was only about 40 per cent.

To get a reasonable idea as to what the initial pressure was we have to find at what pressure, inside the cylinder, the inlet valve will open. Assume that the pressure in the clearance space is 14.7 lbs., and that the pressure on the valve due to the spring is equal to 2.7 lbs. per square inch, then the total pressure acting from inside the cylinder upon the valve is 17.4 lbs. per square inch of valve area, while the pressure acting from the outside is 14.7 lbs. It is evident from this that before the valve opens there must be a difference in the air pressure on the cylinder side of the valve below that of the atmosphere of 2.7 lbs. Of course the actual initial pressure would be slightly less than this 12 lbs. owing to the outer air pressure having to overcome the inertia of the valve spring, so the initial pressure can be safely taken as being not more than 11.7 lbs., thus accounting for a loss

of 20 per cent. of the volumetric efficiency. The remaining 40 per cent. is for the most part due to heat losses.

Whether the pump should have more than one cylinder is largely a matter of choice. A two-cylinder pump can be made well balanced and raises the pressure quickly. With regard to throwing the compressor out of gear, a favored arrangement is to have a small dog clutch to engage with either the driven gear or the pump spindle as the case may be. It is not a difficult matter to design a reliable automatic device to do the work, and as compressed air is at hand why not use it?

Considering what may be done to put this type of self-starter ahead of its present rivals, it is certain that the most serious charge laid against it is the fact that, should a four cylinder motor stop with its cranks at dead center, it is impossible to start with compressed air. The mistake seems to be in allowing the air to enter the engine at all. It does not appear to be at all impossible to design the air pump in such a way that for starting purposes it operates an air motor turning the engine over through gearing.

COMPRESSED AIR AT PANAMA

BY FRED H. COLVIN.

One of the largest air-compressor plants in the world is that which supplies compressed air for the work on the Panama Canal. Of the four separate stations, the one at Empire is the largest and the one at Balboa the smallest. The other two are at Las Cascadas and Rio Grande.

The air compressors at Las Cascadas, Empire and Rio Grande deliver their entire output into a 10-in. main, 14 miles long, from which it is drawn off by smaller subsidiary mains to the air drills and other machinery at various points along the canal. The great majority of the air is used in and around Culebra Cut.

The plant at Balboa comprises two Laidlaw-Dunn-Gordon compressors, each capable of delivering 2,200 cu. ft. of air into a main four miles long. The two plants thus have 18 miles of air-compressor mains, which is believed to be the longest in existence.

The other three plants contain six Laidlaw-Dunn-Gordon compressors of 2,500 cu.ft. capacity each and eight Ingersoll-Rand compressors of the same capacity. The Empire plant

has an average total monthly output of over 400,000,000 cu.ft. of free air at 70 deg. F. The largest total monthly output for all the plants according to the last report, was 794,357,608 cu.ft., while the average cost of it for the year was 3.24c. per 1,000 cu.ft.

The maintenance of the 14 miles of 10-in. main entails a great deal of trouble, due to the changing character of the soil and the constant jarring of the earth from the daily blasts in Culebra Cut. In 1911, 6300 ft. of the main had to be taken up and relaid, due to its proximity to two slides along the banks of the canal. Patrolling these pipe lines has been found advantageous and a good investment in view of the saving effected in the amount of air lost through strained and leaking joints.

A very close account of the cost of compressing the air is kept month by month, the charges being divided into labor and materials for operating the plants, their maintenance, and any extensions which may be necessary.

From oil-fired boilers an evaporation of 14.53 lb. of water per lb. of oil is obtained. Various tests showed that from 157½ to 168 gal. of oil were equivalent to 1 ton of coal.

The lubricating oil is very carefully accounted for, the performance being given in revolutions of the compressors per gallon. The plant at Rio Grande shows 174,000 revolutions per gallon of valve oil, 177,760 revolutions per gallon of engine oil and 461,065 revolutions per gallon of air cylinder oil, while at the Empire plant the last item is 836,875, or nearly double. The output in compressed air per barrel of fuel oil runs remarkably uniform, the lowest being 42,180 cu.ft. of free air per barrel of fuel oil at the Rio Grande plant and 43,196 cu.ft. for the plant at Las Cascadas.—*Power*.

COMPRESSED AIR DISPLACES STEAM FOR OIL BURNING FURNACES

V. S. Nazaroff, engineer of the Transcaucasian Railroads, Russia, has substituted compressed air for steam in the atomization of liquid fuel, his arrangement as applied to a locomotive being shown in the cut, where *C* is the compressed air tank, *b* fuel pipe, and *B* fuel tank, the fuel used being *mazout*, or residues of rock-oil. The disadvantages which were found in the use of steam for the atomization of liquid fuel consisted in trouble and loss of time in starting; explosions in the

furnace produced by the condensation of some of the derivatives of the fuel used forming highly explosive mixtures, and not infrequently burning the firemen; dissociation of steam in the hottest part of the furnace with the formation of a gaseous mixture which on recombining produced noises like pistol shots. All this is said to be eliminated when compressed air is used instead of steam, and further an economy of 38 per cent. in the consumption of fuel is secured.—*Foreign Review A. S. M. E. Journal*.

NOTES

The first military airman killed in actual war was brought crashing to the ground with his aeroplane by shrapnel shells while flying over Adrianople. His name was Popoff, and he had been an aviation instructor in the Russian army.

A standard test code for performance tests of compressors, blowers and exhausters, has been formulated by a committee of the Verein deutscher Ingenieure. It is reported by Prof. L. Prandtl and R. Goetze in the "Zeitschrift des Vereines deutscher Ingenieure."

The real reason why construction work has been suspended on the extension of the Grand Trunk Ry. to Providence, R. I., has at last been discovered. It appears that the draftsmen who are plotting the surveys have not yet been able to spell Lake Chaubunagungamaug. A Welsh draftsman has been cabled for.—*Engineering News*.

A fire occurred in the private automatic telephone switchboard in the Baldwin locomotive works, Philadelphia, caused by a short circuit in the automatic safety device, termed the heat coil. Nothing else being handy, a resourceful person seized a hose connected with the compressed air system and *blow out the fire*.

Breathing can usually be restored after an electric shock within an hour, says *Coal Age*. Keep up artificial breathing for this length of time at least. After breathing starts, begin to restore the circulation by rubbing the limbs briskly in the direction of the heart and under the covers with which the patient has been previously covered.

A company, with \$2,700,000 fully subscribed capital, has been founded in Christiania to produce sulphate of ammonia from the atmosphere after the method of an Austrian engineer, Dr. Serpek. Construction of the mill will commence immediately at Arendal, operation to start in the Autumn of 1914. At first 10,000 hydroelectric horsepower will be used, to be increased later to 25,000. The annual output is calculated to exceed 40,000 tons of sulphate of ammonia.

To John Mabbs, agent of the Isle Royale mine, in the Lake Superior district, belongs the credit for having introduced the power drill to the mining world, says A. H. Meuche, in a recent publication of the Michigan Geological Survey. Mr. Mabbs induced Mr. Rand, who was manufacturing a heavy drill for tunnel work, to make a light and portable one for mine use. With some old engines at the mine he made a compressor and with cast-iron pipe conducted his compressed air underground.

Dr. Marie Stopes of London has been interested for nine years in the study of fossil botany, and has in preparation a book that is expected to throw new light on the subject of coal geology. She has visited the interiors of mines in all parts of the world, including a mine in one of the Japanese islands extending out under the sea. She says coal can not be less than twenty million years old, and that the first plants which entered into its formation were twice as old as that.

Johannesburg is the centre of the gold-mining industry, yet it doesn't seem a bit ashamed of itself. It is a very large and very dusty town, and is principally inhabited by people who are trying to escape from it. Every month something like £1,236,745 worth of gold is worked out of the mines round Johannesburg, but it is not all profit. £1,000,000 may be described as working costs. £236,000 goes to the Government in one way or another, £700 is transferred to the reserve, and the odd £45 is available for distribution among European shareholders.—*Punch*.

Gas from a stalled locomotive in the Northern Pacific Ry. tunnel near Ellensburg, Wash., caused the death of one of the train crew and injury to a number of others, on Nov. 6.

Coal-mining machinery improvements resulted in an increased output in the United States last year of coal mined with machines of 4 million tons over 1910, whereas there was a total decreased output of 11 1-3 million tons.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

NOVEMBER 5.

1,043,080. MOISTURE-SUPPLYING DEVICE FOR CARBURATED AIR. OMER DUIS, Streator, Ill.

1,043,115. FLUID-METER. JOHN W. LEDOUX, Swarthmore, Pa.

1,043,129. BOTTLE-BLOWING MACHINE. JAMES MURPHY, London, England.

1,043,220. PNEUMATIC PIANO-PLAYER. CHARLES FIEBORG, Kankakee, Ill.

1,043,302. ROCK-DRILL. HENRY DEITZ, Denver, Col.

1,043,319. PUMP. OSCAR W. JOHNSON, Rockford, Ill.

1. The combination of a base, a water-cylinder supported thereby, an air-cylinder located below, parallel to said water-cylinder and supported by the base, pistons for the cylinders, a double-faced rack, a connection between the rack and water cylinder piston, a toothed-segment engaging one of said rack faces, a connection between the segment and air-cylinder piston, and means for reciprocating said rack.

1,043,399. STARTING DEVICE FOR EXPLOSIVE-ENGINES. MILTON E. COLE, Akron, Ohio.

1. A starting device for explosive engines comprising a cylinder, a piston therein adapted to be operated by a fluid under pressure, a piston-rod carried by said piston, said piston-rod provided with rack-teeth, a rotatable shaft adapted to be temporarily coupled with a suitable portion of an engine to be started and adapted to be longitudinally shifted into engagement therewith by a fluid under pressure, a gear loosely rotatable on said shaft, a ratchet-wheel fixedly mounted on said shaft, a pawl carried by said gear adapted to engage said ratchet-wheel when said gear is operated in one direction for rotating said shaft, and resilient means for withdrawing said shaft from engagement with said engine portion.

1,043,411. FLOATING DRY-DOCK. GUNNER C. ENGSTRAND, Tompkinsville, N. Y.

1,043,457. SHOCK-ABSORBING SUPPORT FOR PNEUMATIC HAMMERS. REINHOLD A. NORLING, Aurora, Ill.

1,043,464. COMBINED HIGH AND LOW PRESSURE GAS-LAMP. AMANDUS C. ROESLER, Mineola, and WILLIAM A. ARMINGTON, New York, N. Y.

1. In combination, a burner, converging gas and air passages for conducting gas, and air under pressure to said burner, a direct gas passage disposed between the converging passages, and means controlling flow through either of the gas passages.

1,043,529. PNEUMATIC ENGINE OR TOOL. JOSEPH D. MACDONALD, Butte, Mont.

1,043,534. AIR PISTOL OR GUN. GEORGE NORMAN, Birmingham, England.

1,043,593. PNEUMATIC ACTION FOR PIPE-ORGANS. CLARENCE K. HECKMAN, Hagerstown, Md.

1,043,657. AIR-GUN. WALTER H. ALBRIGHT, Bellevue, Ohio.

1,043,677. PNEUMATIC CUSHION FOR VEHICLES. JOHN OWEN DAVIS, Pawnee, Okla.

1,043,704. COMBINATION ALARM DEVICE. MILLER REESE HUTCHISON, New York, N. Y.

NOVEMBER 12.

1,043,803. AIR-BRAKE VALVE. JOHN CHUD-LEIGH, Haberfield, and JOHN WILSON FELL, Sydney, New South Wales, Australia.

1,043,836. PARACHUTE APPARATUS. WIL- LIAM A. HODGE, Milford, Conn.

1. A device of the character described, comprising a compressed air reservoir adapted to be secured to the person of the aeronaut, a valve controlled nozzle for said reservoir, a parachute whose inner face is secured to the upper end of said nozzle, means for resiliently inclosing the parachute and nozzle in collapsed condition, and means controlled by the aeronaut for releasing the parachute and opening said valve.

1,043,880. PNEUMATIC TORPEDO. MAX THOMSEN, Chicago, Ill.

1,044,015. PNEUMATIC INSOLE AND ARCH-SUPPORT. MATTHEW BYRNE, San Francisco, Cal.

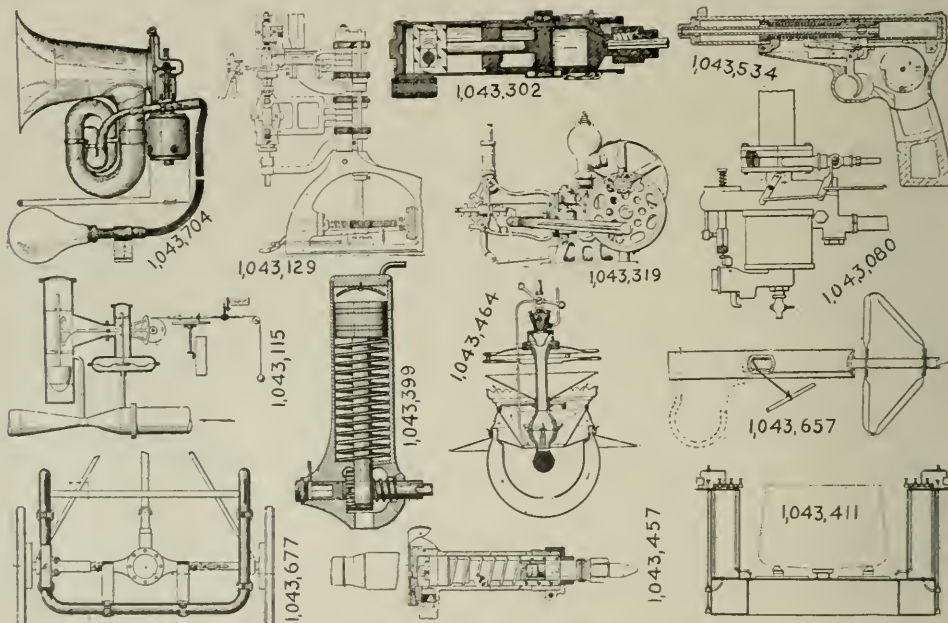
to control the flow of fluid into and out of the said cylinder, a channel for the flow of pressure fluid to said valve, means for operating said valve comprising a rotatable shaft, means for causing the action of said piston to partially rotate said shaft, and a relatively smaller auxiliary piston for further rotating said shaft, and a constantly open connection between said auxiliary cylinder and said source of pressure fluid channel.

1,044,263. PNEUMATIC HAMMER. HENRY SCHUMACHER, Denver, Col.

1,044,275. VACUUM CLEANING DEVICE FOR ANIMALS. JAMES J. SLEVIN, New York, N. Y.

1,044,289. BRAKE FOR AUTOMOBILES. JOHN D. TAYLOR, Edgewood Park, Pa.

1. Means for converting an internal combustion engine into an air pump for braking purposes, comprising in combination means for stopping the supply of fuel to the engine for connecting the fuel inlet of the engine with the atmosphere,



PNEUMATIC PATENTS, NOVEMBER 5.

1,044,031. METHOD OF CAUSING ARTIFICIAL RESPIRATION. JOHANN HEINRICH DRAGER, Lubeck, Germany.

1. The method of producing artificial respiration which comprises filling the lungs from a suitable source of compressed gas until a back pressure of said gas sets in, when the lungs have been filled and diverting the current of gas by said pressure to cause it to move in a direction away from the mouth of the human being so as to produce a suction to discharge the air from the lungs.

1,044,175. CONVERSION OF COAL-TAR, PETROLEUM RESIDUES, CREOSOTE AND SCHIST OILS, AND THE LIKE, INTO PITCH. HENRI HENNEBUTTE, Paris, France.

3. The process of transforming a mixture of tar of high boiling point and oil into pitch consisting in directing air through several columns, in the first of which practically all of the oxygen is removed, and then producing transformation, the air current freed of oxygen carrying vapors which it deposits in the second column.

1,044,197. VALVE-OPERATING MECHANISM FOR MOTORS. JOHN M. LARSON, Chicago, Ill.

1. In a motor having a cylinder and a valve

and means for permitting a free exhaust from the engine at the end portion of a compression stroke; substantially as described.

1,044,337. ROCK-DRILL. THOMAS J. BARBRE and JAMES G. TREFFZ, Denver, Col.

1,044,367. INHALER. GEORGE A. EVANS, New York, N. Y.

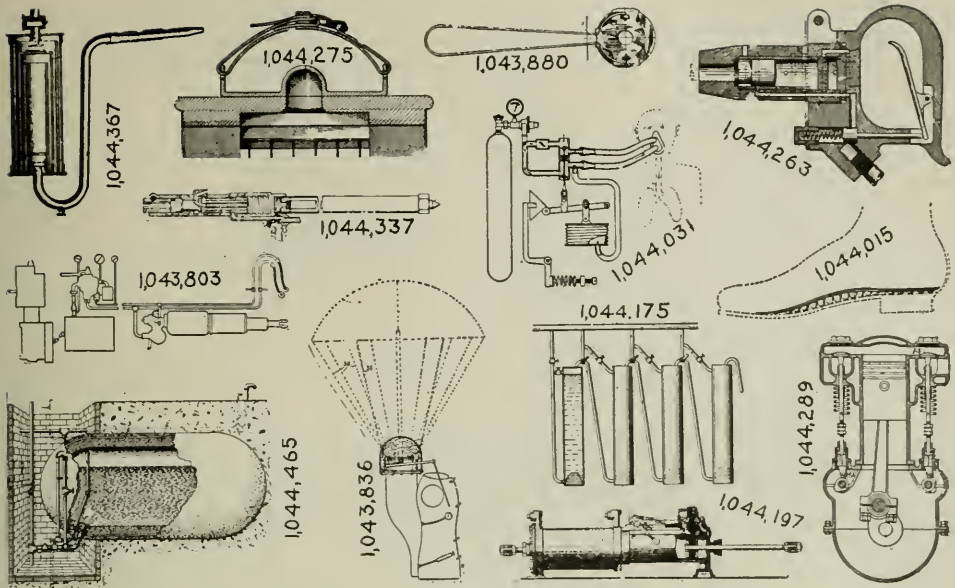
1,044,368. FERMENTATION PROCESS FOR THE PRODUCTION OF ACETONE AND HIGHER ALCOHOLS FROM STARCH, SUGARS, AND OTHER CARBO-HYDRATE MATERIAL. AUGUSTE FERNBACH, Paris, France, and EDWARD HALFORD STRANGE, Staple Inn, London, England.

1. The process of obtaining acetone and higher alcohols which consists in mixing carbo-hydrate matter with water, sterilizing the mixture, adding a ferment of the type of the butylic bacillus of Fritz and then subjecting the mixture to fermentation in the absence of air and leading off and condensing the vapors as they are formed.

1,044,444. FLUID-PRESSURE REGULATOR. JOHN ELOV ENGLSSON, Karlskrona, Sweden.

1,044,465. AIR-PRESSURE RESERVOIR. BERT L. MILLS, Hastings, Neb.

1,044,467. MANUFACTURE OF BREAD. GEORGE LUNT, Formby, England.



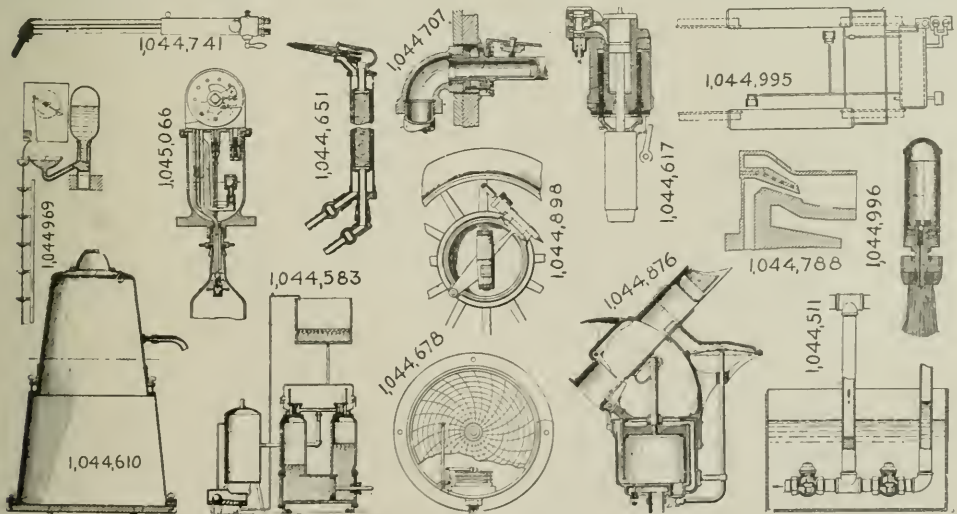
PNEUMATIC PATENTS, NOVEMBER 12.

3. A process for the treatment of dough consisting in allowing the dough to rest after complete mixing of its ingredients for a part of its normal period of fermentation and subdividing it in a free-oxygen-containing gaseous atmosphere under pressure and recombining the dough particles while still in this gaseous atmosphere.

NOVEMBER 19.

- 1,044,511. PUMP FOR EXPLOSIVE GAS. JOHN C. FOUNTAIN, London, Ontario, Canada.
 1,044,583. AIR-COMPRESSOR. WILSON SELAKOSKY, White Haven, Pa.
 1,044,610. VACUUM APPARATUS. ALFRED WENDER, St. Louis, Mo.

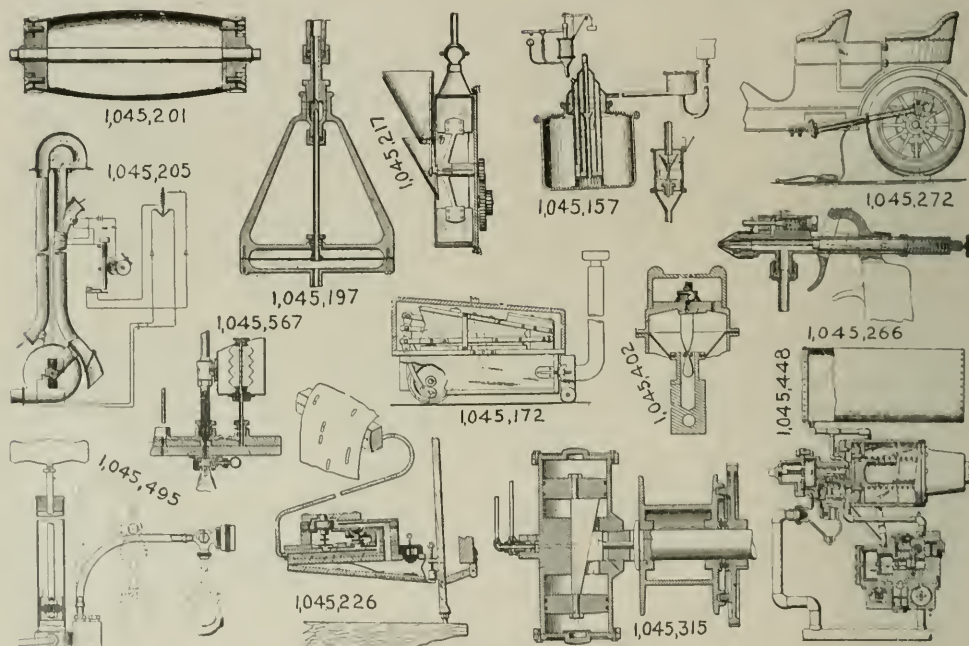
- 1,044,613. DUST SEPARATOR AND FILTERING MECHANISM FOR VACUUM-CLEANERS. THEODORE WIEDEMANN and JOSEPH H. TEMPLIN, Philadelphia, Pa.
 1,044,617. HAMMER-PRESS. EDWARD H. WRAY, Philadelphia, and LOUIS M. PYLE, Bryn Mawr, Pa.
 1,044,636. PNEUMATIC PIANO-PLAYER. CHARLES FREBORG, Kankakee, Ill.
 1,044,651. BLOWPIPE. JOHN HARRIS, Cleveland, Ohio.
 1,044,653. APPARATUS FOR STERILIZING WATER. SIEGFRIED HELD, Chicago, Ill.
 1,044,678. RECORDING LOW-PRESSURE GAGE. COLEMAN J. MANNING, Medford, Mass.
 1,044,707. CLOSURE FOR AIR-SUCTION



PNEUMATIC PATENTS, NOVEMBER 19.

- PIPES. WILLIAM S. SUTTON, Rockford, Ill.
 1,044,741. CUTTING-TORCH. WORTHY C. BECKNAM, Jersey City, N. J.
 1,044,788. AIR-COOLED OPEN-HEARTH FURNACE. HENRY KNOTH, Monterey, Mexico.
 1,044,876. PNEUMATIC-DESPATCH-TUBE APPARATUS. EDMOND A. FORDYCE, Boston, Mass.
 1,044,898. FLUID-PRESSURE-CONTROLLING SYSTEM FOR MOTOR-VEHICLES. ALEXANDER GRANT MCGREGOR, Salt Lake City, Utah.
 1,044,969. APPARATUS FOR TESTING AIR OR OTHER GASES. MAX ARNDT, Aix-la-Chapelle, Germany.
 1,044,995. AIR-MOTOR. WILLIAM CREELY, Bay City, Mich.
 1,044,996. BRUSH. WILLIAM CUTHBERTSON, Chicago, Ill.

- 1,045,205. TRANSFER-TUBE SYSTEM. JOHN P. SKIRROW, East Orange, N. J.
 1,045,217. TREE-SPRAYER. FRANK M. THOMAS, Muncie, Ind.
 1,045,226. PNEUMATIC ACTION FOR SINGLE-SYSTEM MUSICAL INSTRUMENTS. PETER WELIN, Worcester, Mass.
 1,045,260. EMERGENCY OPERATING DEVICE FOR AIR-BRAKES. GEORGE L. COLLINS, Hickman, Ky.
 1,045,266. AIR-BRUSH. THOMAS A. DE VILBISS, Toledo, Ohio.
 1,045,272. MEANS FOR ATTACHING AIR-PUMPS TO AUTOMOBILES. EDWIN W. FISHBURN, Denver, Col.
 1,045,315. FLUID-ACTUATED CLUTCH. FRED C. MOTT, Satsop, Wash.
 1,045,373. HIGH-POWER AIR-RIFLE. EDGAR P. COOK, Granville, Ohio.



PNEUMATIC PATENTS, NOVEMBER 26.

1. In a brush the combination with a hollow cylindrical handle adapted to contain a liquid, of a piston, cup valve and piston rod having a duct therethrough, an air chamber, and means for operating said piston rod.
 1,045,066. METHOD OF AERATING LIQUIDS. LUDWIG NEUMAYER, Strassburg, Germany.
 The herein described method of aerating liquid, consisting in supplying gas under pressure to a column of confined liquid, permitting a portion of the gas to escape from the column of liquid and subsequently confining the escaping gas, and finally subjecting the column of liquid to an additional charge of gas and forcing the aerated liquid in sprays to the confined gas previously expelled from the column of liquid.

NOVEMBER 26.

- 1,045,157. AUTOMATIC CHEMICAL AIR-LIFT. AUGUST LONG, Bayonne, N. J.
 1,045,172. PNEUMATIC PUMP. THEODORE O. OSTERHOLM, Worcester, Mass.
 1,045,197. PRESSURE-REGULATOR. PETER J. SCHULER, New Hampton, Iowa.
 1,045,201. PNEUMATIC ROLL. CHARLES GUY SHOOP, Beloit, Wis.

- 1,045,402. PULSATOR FOR PNEUMATIC MILKING. CHRISTIAN VALDEMAR HENRICHSEN, Copenhagen, Denmark.
 1,045,448. AIR-BRAKE APPLIANCE. WALTER A. SKINNER, Moberly, and THOMAS F. CAIN, Montgomery City, Mo.
 1,045,462. LUBRICATOR FOR AIR-PUMPS. WALTER V. TURNER, Edgewood, Pa.
 1,045,495. TIRE-INFLATING PUMP. HENRY K. AUSTIN, Reading, Mass.
 1,045,542. X-RAY-TUBE VACUUM-CONTROLLER. CERAN GAVEAU, New York City.
 1,045,567. MACHINE FOR BOTTLING LIQUIDS UNDER PRESSURE. JOHANNES KARLSSON LANNMARK, Stockholm, Sweden.
 1. In a machine for bottling liquids under pressure, the combination of a receiver for the liquid, a compressible air receiver placed inside and separated from the said receiver for the liquid and connected with the interior of a bottle when in position to be filled, and means for discharging the air from the said compressible air receiver before a second bottle is placed in position to be filled.
 1,045,710. PNEUMATIC PIANO-ACTION. WALTER A. KRUCK, Camden, N. J.

COMPRESSED AIR

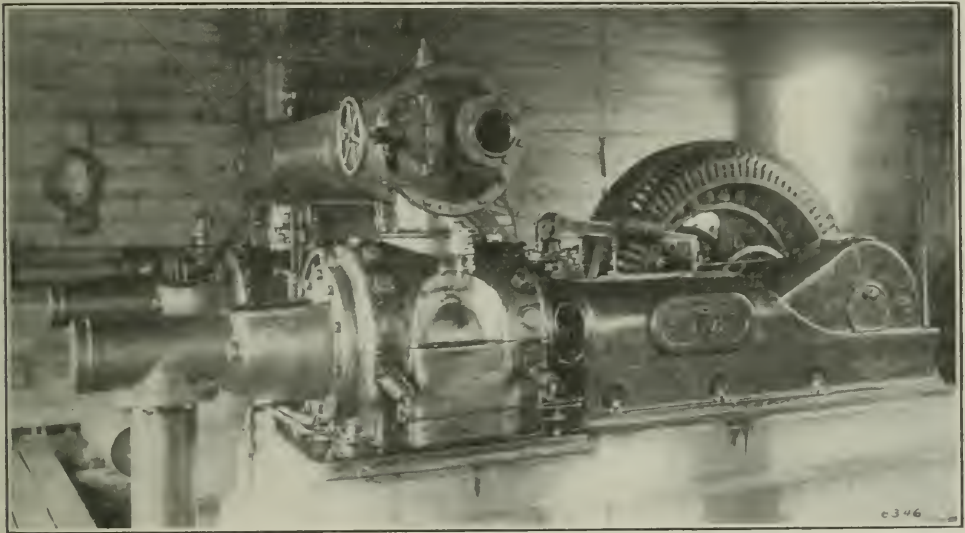
MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XVIII

FEBRUARY, 1913

No. 2



COMPRESSOR AT WICKWIRE MINE.

RECENT ELECTRIC DRIVES IN IRON MINING

BY C. A. TUPPER.

For several years attempts have been made in iron mining districts to introduce the use of electric power on an extensive scale for the operation of both surface machinery and underground equipment, beginning usually with the pumps, compressors and hoists. The progress made, however, has not been what might have been expected from the success of the electric drive in other industrial fields. This has been due mainly to the peculiar problems involved, which vary radically for each class of equipment.

At first the attempt was invariably made to

take existing types, including both the driven machines and the motors, and to couple up the two for operation—whether directly, with gearing, or through belting—without much regard to the particular characteristics of either. The results were in most cases very unsatisfactory and delayed for a considerable time the actual electrification of many important properties.

Gradually it became apparent to manufacturers and users of mining machinery, the same as it had earlier to operators in the metal working field, that what was needed was the practical redesigning of both driven machines and motors, and to a considerable extent the introduction of much higher speeds to meet the exacting conditions of mining service.

Among the various problems presented, that of electrically operated air compressors has been prominent, and during a recent trip over the northern iron ranges the writer was greatly interested in observing the progress made there within the past year.

One of the pioneers in bringing about the new order of things is the Cleveland-Cliffs Iron Co., but examples of equal interest are to be found in the Iron river district of the Menominee range, where several motor-driven compressors of the larger capacities recently were placed in service. The first of these plants visited by the writer were those of the Wickwire Mining Co., at the Wickwire and Cortland mines, Iron Range, Mich., the details of which are decidedly instructive.

The compressor installed at the Wickwire mine is an Ingersoll-Rand P. E. 2, two-stage machine, having air cylinders $18\frac{1}{4}$ inches and $11\frac{1}{4}$ inches in diameter by 16-inch stroke. At 225 revolutions per minute it delivers 995 cubic feet of free air per minute, the receiver pressure being 100 pounds. The writer was chiefly interested, at the start, in considering this unit from the standpoint of compressor design, and will, therefore, take up the various basic features of construction before entering upon the auxiliary details which form part of the operation of the plant as a whole.

The first feature to attract attention in a high speed compressor of this type, even from superficial observation, is that the frame on each is of the unit, heavy-duty engine design, supported for its entire length on the foundation, while the cylinders, resting on sole plates, are made with a full box underneath instead of a foot. The whole of this box is a part of the water jacket and serves as a settling chamber. Next, it is noted that the compressor is accessible, both inside and outside. At the driving end are the main bearings, of the three-part pattern, in which a film of oil is constantly maintained between the shaft and the babbitted shells. On the sides are the cranks, cross-heads and connecting rods. These are accessible, while the machine is in operation, through the front and top doors on the oil guards and through a large door on the side of the main frame. The air pistons can be withdrawn at the back.

The air cylinders, cooling system and method of lubrication have also a story of interest for the close observer. The hurricane piston

inlet valve is employed for the air intake of both valves. This ingenious and efficient device it is not necessary to describe here. The discharge valves are of the cushioned, direct lift type. These valves are arranged radially in the cylinder and seat directly on the metal of the barrel, thus not only rendering any removable valve seats unnecessary, but also leaving the head free to be completely water jacketed.

The system of lubrication is particularly effective. It provides for delivering a constant stream of oil to the main bearings, crank pins and crosshead pins. The flow of oil begins as the machine starts and its delivery is automatically proportioned to the speed. For lubricating the air cylinders, where a minimum of oil is required, adjustable sight feed lubricators are provided.

THE MOTOR.

The design of this machine, as a cross-compound compressor, lent itself admirably to the electric drive, the motor being placed between the main bearings with the rotor pressed and keyed on the shaft. This was a Westinghouse synchronous motor of 170 horse power capacity, operating on three-phase, 60 cycle, alternating current at 2,200 volts.

The Wickwire mine appears to be partially drained through other properties. It makes about 200 gallons of water per minute. This quantity was handled by a No. 8 Cameron pump of 150 gallons rated capacity, but to provide for the increased volume of water which will result from the further opening of the mine, the management installed a Buffalo Steam Pump Co.'s two-stage, 3-inch centrifugal unit of 300 gallons delivery per minute, against a head of 119 feet. This is driven by a 35 horse power, 1,200 revolutions per minute, General Electric synchronous motor.

The water pumped from the Wickwire mine is first discharged into a cylindrical tank outside the power house. From this it flows through piping to the compressor where it enters the bottom of the low pressure cylinder head, passes out at the top, and thence to the bottom of each end of the cylinder, to the top of the water space. From the low pressure side of the compressor the water circulation continues on through the intercooler, which is set transversely above and connects the air cylinders. From the compressor jackets and the intercooler the stream of cooling water

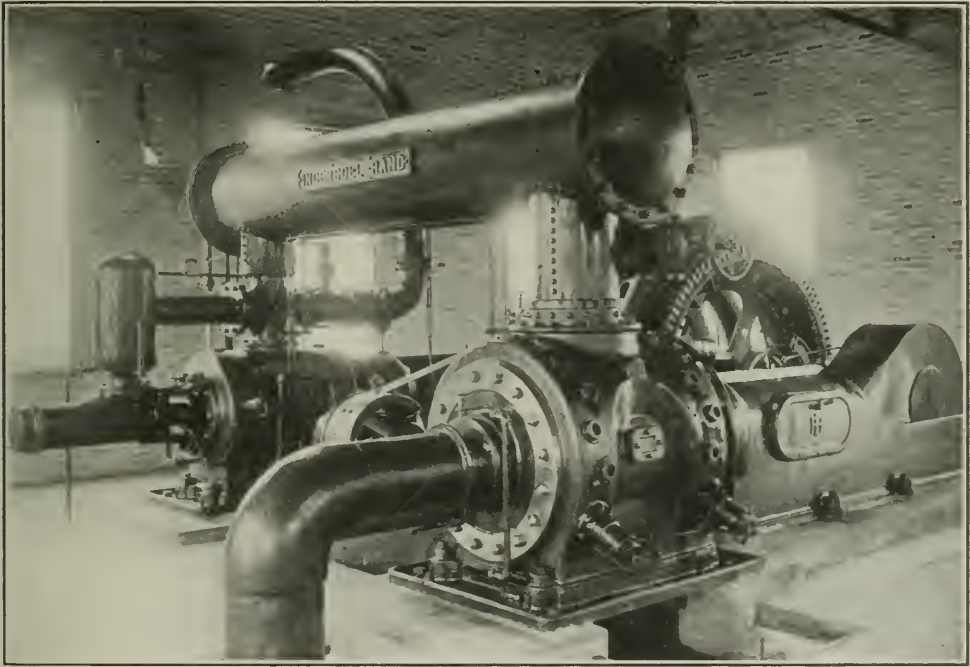
flows to a wooden tank and is fed by an injector to the boilers.

The electric power used in the Wickwire and Cortland mines is purchased from the Peninsular Power Co. at the very low rate of 1 cent per kilowatt-hour, or higher if 60 per cent. load factor is not maintained. Current comes in at 6,600 volts, and is stepped down to 2,200 volts at the Wickwire mine, by three Westinghouse 125-kilovolt-ampere, oil-cooled transformers, at the same time being measured

pressed air. The arrangement of the incoming electric line is similar to that described. There are three, 125-kilovolt-ampere Westinghouse 2,200-2,20-volt transformers, lightning arrester and the necessary switchboard panels.

REGULATION OF THE COMPRESSORS.

Regulation of the compressors at the Wickwire and Cortland mines is effected in five stages—full load, three-quarter load, one-half load, one-quarter load and no load—by means of an automatic clearance controller. This



COMPRESSOR AT CORTLAND MINE.

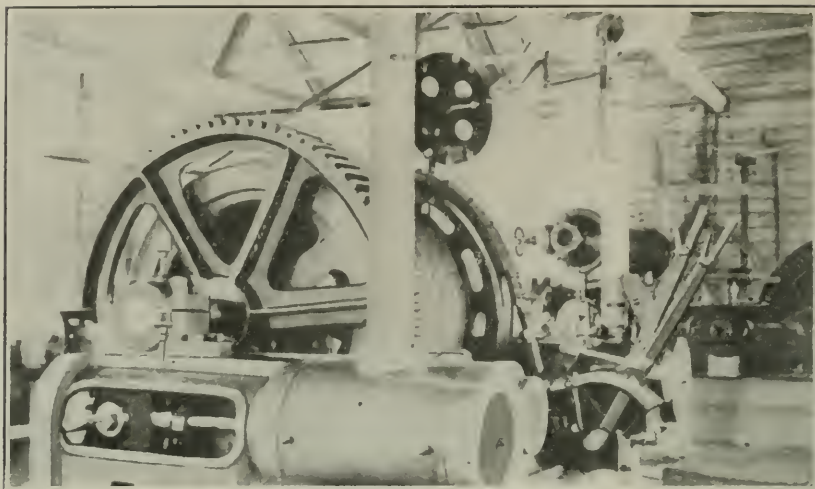
by a Thompson high torque wattmeter. The incoming lines are equipped with a Westinghouse lightning arrester, and are controlled from a panel fitted with Westinghouse apparatus. There is a Westinghouse switchboard for the 170-horsepower motor driving the compressor and its 6-kilowatt exciter.

At the Cortland mine the compressor is also an Ingersoll-Rand machine, driven by a Westinghouse motor of the same design as the above, but larger, being $12\frac{1}{2}$ and $21\frac{1}{4} \times 18$ inches. It supplies 1,352 cubic feet of free air per minute at 200 revolutions per minute. The motor is rated at 200 horsepower with a 5-kilowatt exciter. The hoist is run by com-

pressed air. The arrangement of the incoming electric line is similar to that described. There are three, 125-kilovolt-ampere Westinghouse 2,200-2,20-volt transformers, lightning arrester and the necessary switchboard panels.

Regulation of the compressors at the Wickwire and Cortland mines is effected in five stages—full load, three-quarter load, one-half load, one-quarter load and no load—by means of an automatic clearance controller. This

consists of a number of clearance pockets which are thrown automatically into communication with the ends of each air cylinder in proper succession, according to a pre-determined variation in receiver pressure. With the compressor operating at partial capacity, a portion of the air is compressed into added clearance space instead of passing through the discharge valves. On the return stroke this air expands, giving up its stored energy to the pistons. The inlet valves remain closed until the cylinder pressure equals the intake pressure. The inlet valve then opens, and free air is admitted to the cylinder for the remainder of the return stroke. Thus the inlet capacity



AIR DRIVEN HOISTING ENGINE.

of the compressor is lowered without reducing the intake pressure. The Wickwire Mining Co.'s units being each two-stage machines, clearance space in the proper proportion is added simultaneously to both low and high pressure cylinders, thus maintaining a constant ratio of compression over the entire load range. This system of regulation is a very desirable one under conditions, such as those above mentioned, where electric power is purchased on the basis of a special maximum demand charge, as it permits the motor to be operated at a higher load factor than would otherwise be possible.

To further eliminate the necessity for peaks and hollows in its load curve, the company contemplates constructing an underground chamber, below the mine sump, for storage of air, utilizing a column of water to give the effect of a hydraulic accumulator. This will enable the compressor to be run at constant speed, under practically ideal conditions of efficiency, and the hoist can then be operated by air, admitted to its cylinders, instead of steam, in a manner similar to those of the Oliver Iron Mining Co. at Iron Mountain, Mich., where compressed air is piped in from a distant plant operated by water power.

DAVIDSON COMPRESSOR STATION.

Following the inspection of the Wickwire Mining Co.'s plant, the writer visited the new compressor station of the Davidson Ore Mining Co., north of Iron river, where the compressor is an Ingersoll-Rand P. E. machine of

much larger capacity, having a delivery of 2,500 cubic feet per minute.

The compressor at the Davidson mine, a unit similar to which will shortly be put in service at the Bengal mine, Palatka, Mich., of the Verona Mining Co., is driven by a Westinghouse synchronous motor of 400 horsepower capacity, 2,200 volts, at 150 revolutions per minute, with a 10-kilowatt exciter. Current from the Peninsular Power Co.'s mains is received through three 125-kilovolt-ampere, oil-cooled, Westinghouse transformers, and the circuit is protected by a Westinghouse lightning arrester. The usual switchboard and other auxiliary apparatus have been installed.

USE OF SYNCHRONOUS MOTOR

In the decision of various mining companies to adopt electrically-driven compressors, the use of the synchronous motor and its characteristic of building-up or equalizing the power factor of the system has played a leading part.

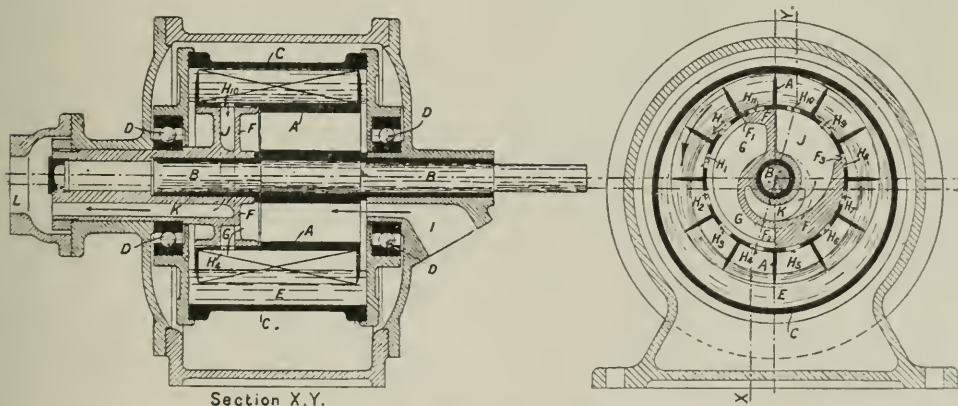
A synchronous motor will operate at any desired power factor. Varying the strength of the direct current exciting the field magnets, which can readily be done by an attendant while the machine is running, will cause a variation in the power factor. In this manner it cannot only be raised to any degree, but can be made to neutralize the effect of other apparatus having a lower power factor, thus bringing the value in the main transmission line and on the generator up to 100 per cent.

irrespective of the deficiency in this respect of other apparatus.

The synchronous motor can be constructed to operate equally well on single phase, two-phase or three-phase circuits, with, of course, the proper winding in each case. When its fields are fully excited and it has been brought up to its rated speed, which can be done by a small induction or direct current motor mounted on the same shaft, or by a special winding on the rotor, current can be thrown on from the main supply as soon as synchronism is indicated by lamps or by a suitable instrument on the starting panel. Then, provided the speed of the main generator is suitably regulated, this type of motor will run at absolutely constant speed from no load up to a very heavy overload. Its use is generally restricted to a special service and large units, such as those described, owing to the fact that a direct current exciter must be provided and that in its simpler forms it is not self-starting, even under no load; but for the conditions of compressor service mentioned, it is practically an ideal machine, and its application in this direction is being rapidly extended.

pumps for pumping gases. The essence of the invention consists in the blade wheel being arranged in a freely revolvable drum, which is mounted eccentrically with regard to the blade wheel and which is intended for the reception of a working fluid.

The apparatus will be readily understood by the aid of the accompanying engraving, the drawing on the left hand of which is a section on the line X Y in the righthand view. It will be seen that a star or blade wheel A is carried on a shaft B and is revolved by it. The star wheel is mounted eccentrically inside the closed casing C, which revolves with very slight friction owing to its being provided with the ball bearings D. The casing is watertight and it contains the working liquid E, which, may be, say, water. The effect of revolving the blade wheel is to set the water in motion, and very soon after the blade wheel has been started the whole volume of water is revolving and is thrown out by centrifugal force against the internal periphery of the casing. The effect of the friction between the water and the casing is to cause the latter to revolve, which it does, we are informed, almost as soon as the star wheel is started, its



EISERMANN-LEHNE BLOWER.

A NEW BLOWER

We have lately had brought to our notice a new and ingenious type of blower which is the invention of two German engineers, Herr Rudolf Eisermann and Josef Lehne, whose English patent No. 8104 of 1912 is now owned by the Internationale Rotations-Maschinengesellschaft m.b.h., of Berlin. The invention relates to bucket-wheel or blade-wheel pumps in general and in particular to blade wheel

speed gradually rising until it is practically the same as that of the water. When this condition has been reached the working liquid is by the action of centrifugal force made to form a ring of equal depth all the way round the inside of the casing, the depth of liquid being just sufficient to form a seal at the top of the star wheel as seen in the right-hand view in the drawing.

One end of the wheel A just fits over and

can revolve on a fixed dividing piece F which has several functions. The gas which it is proposed to compress or pump is allowed to enter the apparatus through the passage I , which is in direct communication with the passage G in the dividing piece F . The star wheel A has a number of slots or ports— H , H_1 , H_2 ... H_{11} —in its periphery in the centres of the parts coming between the blades. It will be seen in the right-hand section that as the gas to be dealt with is in the passage G it will pass through the ports H , H_1 , H_2 , H_3 , and H_4 and will fill the compartments formed between the blades of the wheel and the surface of the ring of working liquid. As soon as by the revolution of the wheel any one of the ports—in this case H_5 —has been covered by the lip F_2 of the dividing piece F no further gas can enter that particular compartment. Nor can any gas escape from this or the two compartments immediately in front of it. In the case of the third compartment from H_5 , that is to say, in H_8 , matters are different, for the port has been uncovered by its passing beyond the lip F_3 .

The result will be readily understood. It will be observed that as the wheel keeps on revolving the size of each successive compartment is gradually decreased, so that the gas when it escapes into the receiving chamber J through the port H_9 is considerably compressed, and compressed gas also escapes into J through the ports H_9 and H_{10} . By reason of the liquid seal, which has already been referred to as existing at the top of the star wheel, no compressed gas can leak past from J to G and no free gas can get through the port H_{11} until it is uncovered by traveling past the lip F_4 . The compressed gas receiving chamber J is in communication with the passage K which leads to the discharge nozzle L of the apparatus.

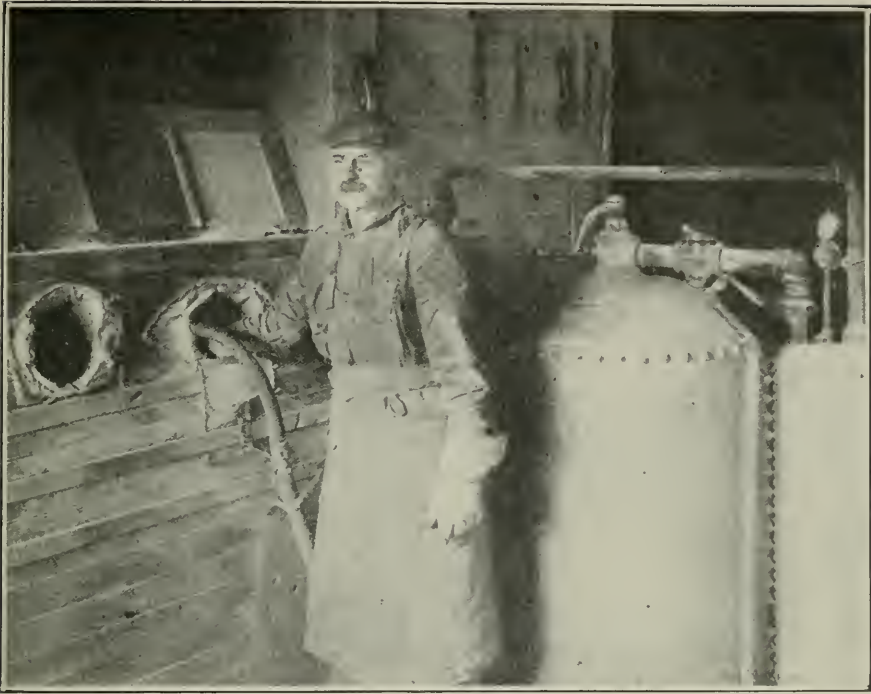
The whole thing is wonderfully simple, and we understand that it works well. We gather that tests made with a blower having a star wheel $3\frac{1}{4}$ inches in internal diameter and $2\frac{1}{4}$ inches in width have shown a pressure above that of the atmosphere of about 20 pounds per square inch with the delivery pipe completely closed and with the wheel revolving at a speed of 3,600 revolutions per minute; while at the same speed and with the suction aperture closed a vacuum of about 24 inches of mercury was obtained. In some

further tests, of which the makers have given us particulars, the pressures were taken up to an equivalent of a column of 16 inches of mercury, the volume of air delivered being carefully measured. The efficiency under these conditions was about 70 per cent. The efficiency when producing a vacuum is given as being about 60 per cent. With larger machines we are informed that pressures up to 30 pounds per square inch and a vacuum of 95 per cent. of that theoretically possible have been obtained.

The blowers can be made to work with the spindles vertical as well as horizontal. It is claimed for the apparatus that the losses due to jerks and liquid friction, which are large in many kinds of blowers of this type, are minimised, and that the principal losses, which result in other machines from the fact that the greater part of the energy communicated to the working liquid is wasted and has to be continuously replaced in the working of the cycle, are very nearly entirely done away with. When once the inertia of the water and the casing is overcome but little energy is required to keep them both revolving.—*The Engineer, London.*

VARIOUS WATERS

Rain-water collected after a long period of wet weather is the purest natural water. It contains atmospheric air and gases in the proportion of about 2.5 cubic inches to every 100 cubic inches of water. River water is the next purest, then comes the water of lakes, ponds, ordinary springs and mineral springs. Following these waters come arms of the ocean lying in the vicinity of the mouth or discharge of great rivers, then follows the water of the main ocean and last of all the waters of lakes, like the Dead Sea, Caspian Sea, and the salt lakes of Utah. Spring water although perfectly transparent contains more or less mineral matter dissolved in it. The nature of these impurities will depend on the character of the soil through which the water percolates. The most general impurities are carbonate of lime, common salt, sulphate of lime (sometimes called gypsum), sulphate and carbonate of Magnesia and compounds of iron. Most spring waters contain a certain proportion of carbonic acid gas.



OPERATOR WELL PROTECTED.

TO PROTECT THE SANDBLAST OPERATOR

The half tone here reproduced from the *American Machinist* shows an arrangement in use at the plant of the New Process Raw Hide Company, Syracuse, N. Y. The sandblast apparatus is in a detached building, which is divided into two rooms. The large one, seen in the illustration, has the sand-storage bins, separator and sandblast machinery. The smaller is the working room where the cleaning is done. The operator is in the outer room as shown, which is free from flying dust. He puts his arms through the holes in the partition which encloses the smaller room, these holes being protected by canvas flaps to keep sand from blowing back through them. At a convenient height for the operator's eyes is a three-pane sash through which he can look and see the work going on inside. The work is mostly small pieces that are easily handled on a table set at a convenient height to be reached by the workman's hands. An interesting point is the sandblasting of the glass through which he looks.

This cuts so rapidly that a new pane must be put in for each day's run.

TESTS OF A TURBO COMPRESSOR

Descriptions and data of tests of a turbo-compressor plant at the Westerholt mine, Ruhr district, Prussia, have recently been published in *Glückauf*. The turbine driving the compressor is so arranged as to be able to work both with live and exhaust steam, while the compressor can take in either 10,000 cbm (say 35,000 cu. ft.) of air per hour and compress it to 6 atmospheres, itself running at 4,400 r.p.m., or it can run at 4,200 r.p.m., and compress to 5.5 atmospheres, 5,000 cbm of outside air. The consumption of steam was guaranteed to be: for exhaust steam only, when handling 10,000 cbm, 1.4 kg/cbm (say 0.04 lb. per cu. ft.), for 5,000 cbm, 1.78 kg/cbm (say 0.051 lb. per cu. ft.); for live steam only 0.69 kg/cbm and 0.88 (say 0.02 and 0.025 lb. per cu. ft.) for the full and half load respectively. The actual test values are slightly more favorable than these. The article contains full data of the test.

VARIOUS PNEUMATIC DEVICES

In the cut on the opposite page are grouped sketches from various sources of a number of devices such as are continually developing wherever a supply of compressed air exists, and especially when active brains acquire the habit of thinking compressed air.

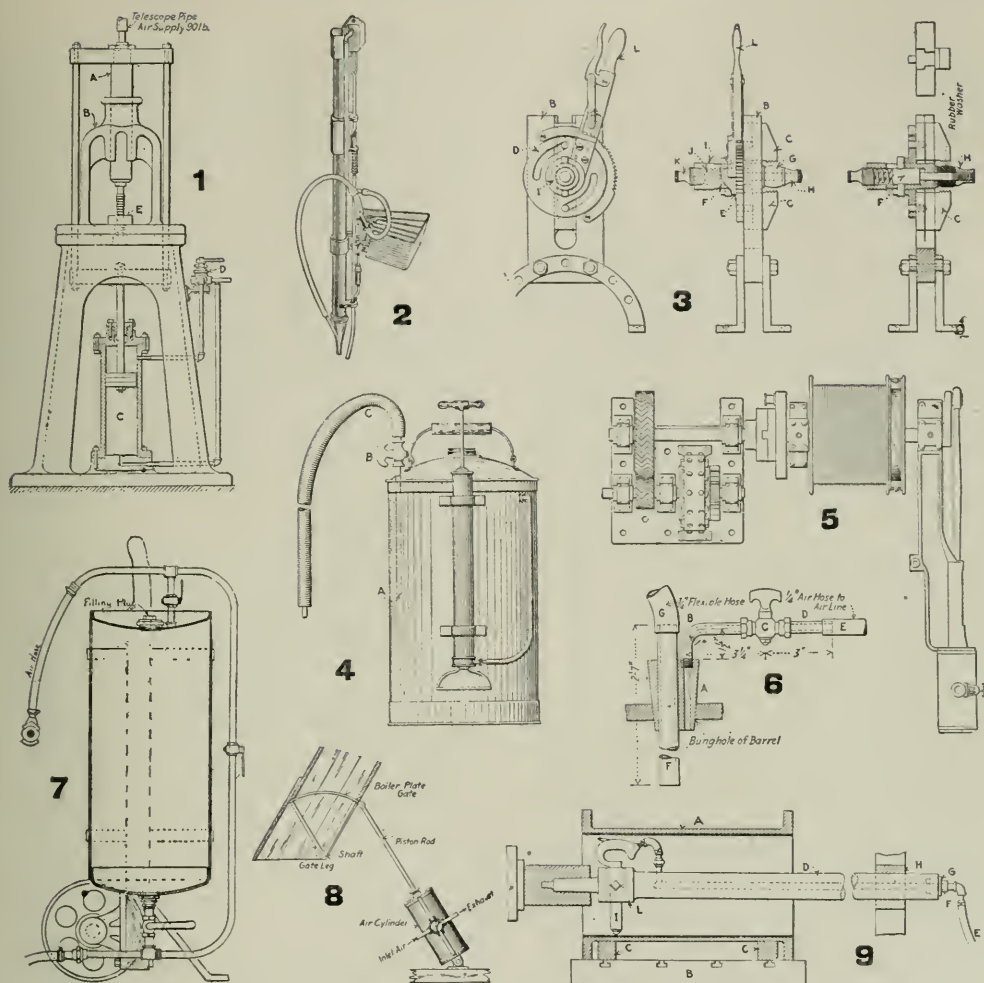
Fig. 1, from the *American Machinist*, shows how a pneumatic hammer was used as a broaching tool. The hammer does not differ from ordinary tools of this type except that it is made heavier, as the extra weight helps to keep it down to the work. In operation the hammer *A* is raised to the top of the guide frame *B* by means of the piston in cylinder *C* and its connecting side rods extending to the top, the air for operating this piston being controlled by the four-way valve *D*. The broaching tool is inserted in the work *E*, and the hammer brought down on it by reversing the four-way valve and introducing pressure above the piston in the cylinder. The air pressure is then admitted to the hammer by means of a valve (not shown) operated by a pedal. As the hammer drives the broach through the work, it is kept down to its work by the pressure on the cylinder, thereby increasing the force of the blow by eliminating all rebound. The work shown is tool steel $2\frac{1}{2}$ in. in diameter, 1 in. thick and has a $1\frac{1}{16}$ -in. square hole with corners rounding $\frac{1}{16}$ -in. radius. It is done in one operation with a broach 14 in. long.

Fig. 2 is a pneumatic nail-driving hammer, particularly designed for use by carpenters in nailing laths. Attached to the tube containing the piston or hammer is a nail box or hopper having a capacity of about 250 nails. The vibrating of this hopper causes the nails to be tripped up and forced, one at a time, into a rubber tube, through which they are forced to the head of the hammer by the compressed air. Protruding slightly over the head of the hammer is a trip rod which, when forced against the wall or object to be nailed, allows the nail to be set in the hammer head, and also releases the trigger which allows the compressed air to pass into the power chamber. The piston rod, striking the hammer, then drives the nail home. The weight of the hammer is about $3\frac{1}{2}$ lb., and a speed of 100 nails a minute can be attained.

Fig. 3, from the *American Machinist*, shows an air-hose testing device produced for the Canadian Pacific Ry., Angus Shops, Montreal,

for holding the threaded end of air hose while testing it under air pressure. It consists of the upright piece *B* slotted down the center to receive the hardened tool-steel jaws *C*. The gripping faces of the jaws are threaded to correspond to the threads on the air-hose connection. The jaws also have two studs screwed in at the back, which project into slots cut in the cam plate *D*. This cam plate also carries the double-rise cam *E*, thus serving the double purpose of closing the jaws and drawing in the bolt *EF*, which compresses the rubber washer *G* lengthwise, causing it to expand radially. An adjusting nut *H* is screwed on the bolt *F*. The sleeve *I* is screwed into the center of the body and holds the cam in position; it also holds the bolt *F*, the spring *J* and the guide plug *K*. It has two slots on opposite sides which allow the passage of the pin intersecting the large end of the bolt *F*, and on which the cam *E* acts to draw in the bolt *F*. The action of the lever *L* and the method of locking it in various positions on the ratchet, are obvious. The brackets holding the device are so made that the device may be set at whatever angle is most convenient for the operator. In operation the air-hose connection is slipped over the rubber washer *G* and between the two jaws. The lever is pulled down, closing the jaws on the threaded end of the connection while the rubber washer is expanded inside the connection, making it airtight, and at the same time holding it firmly, while the air is applied to the other end. Soapy water is put over the hose to detect any air leakage.

Fig. 4, from *Power*, shows a can for taking up oil from places difficult of access in the usual way. The can is the ordinary galvanized, 5-gal. size and the pump is of the bicycle variety with a leather plunger. A metal valve stem is soldered on the bottom end in place of the hose connection found on the pump. To the valve stem or check valve, is attached a small rubber hose, the other end of which is connected to the top of the can. A small pipe *A* is soldered on the top of the can, to which is attached a small petcock *B* and a piece of rubber hose *C*. Gaskets should be placed under the caps on top of the can to make them airtight. A few strokes of the pump removes the air from the can, whereupon, by placing the end of hose in the oil to be cannled, and opening the cock, the oil flows into the can.



VARIOUS PNEUMATIC DEVICES.

Fig. 5 also is from *Power* and illustrates the following: At a certain mine compressed air is used to operate the brake on a single-drum, direct-motion, Corliss winding engine handling but one cage for elevating men from the mine 1,000 ft. below the surface. The engine had originally been steam-driven, having two 18x48-in. high-pressure cylinders. An 8-ft. drum was mounted on the shaft. The engine has been remodeled and is now driven by a 720-hp. geared motor. The gear teeth are of the double-herringbone type and have a ratio of 4.5 to 1. The pinion is made of nickel steel and the spur wheel of cast steel, the shaft of which couples direct to the drum

shaft by a "ham" coupling. One cylinder of the engine is used, the crosshead and connecting-rod being coupled to the crank. On the coupling side of the drum the crank has been removed and a crank disk substituted which contains the male side of the coupling. In lowering the men, the post brake is released and the cage descends of its own weight to the bottom of the shaft. While the rope and drum are paying out the steam cylinder is turned into an air compressor, as the valve-gear is still on the cylinder side and the reversing link is set against the engine. The exhaust valves therefore are the admission valves and the former admission valves are

the exhaust valves. The air is compressed against a special relief valve under the operators' platform, which is operated by a lever. The operator controls the speed of the drum by opening and closing this relief valve, reducing or increasing the air pressure against the engine piston.

Fig. 6 shows a device employing compressed air for transferring oil from barrels to storage tanks. A cast-iron plug A is made to fit the bung hole of the barrel, a $\frac{1}{4}$ -in. air pipe B is tapped into the top of the plug and a $\frac{1}{4}$ in. air valve C is screwed on this air pipe. A short nipple D and a $\frac{1}{4}$ -in. air hose E are secured on the end of the nipple and connected to the main air line. The hose should be long enough for the device to be moved from tank to tank. A $\frac{3}{4}$ -in. standpipe F should slide snugly through the cast-iron plug so no oil can escape. On the end of the $\frac{3}{4}$ -in. pipe is a $\frac{3}{4}$ -in. flexible hose G long enough to reach the inlet of the tank. Roll the barrel near the tank, take out the barrel plug and insert the cast-iron plug by giving a few taps with a hammer so as to make a tight fit, force the $\frac{3}{4}$ -in. pipe to the bottom of the barrel, connect the flexible hose to the tank, turn on the air, and in a few minutes the barrel will be empty.

Fig. 7, from *Railway and Locomotive Engineering*, shows a sand blast machine cheaply made in a railroad repair shop. It has proved itself very useful in sand blasting tenders that are badly pitted. This machine does rapid and good work and, of course, its operations are best suited for the open air. As shown in the illustration, the apparatus is portable, and the hose attachment may be lengthened to suit any condition. The nozzle may be made of brass and the opening need not be more than one-quarter of an inch in diameter at the point, and tapering inwardly for four inches to a diameter of half an inch. The socket and other attachments should be free from sharp corners. A machine of this kind is not only easily made, but will speedily pay for itself.

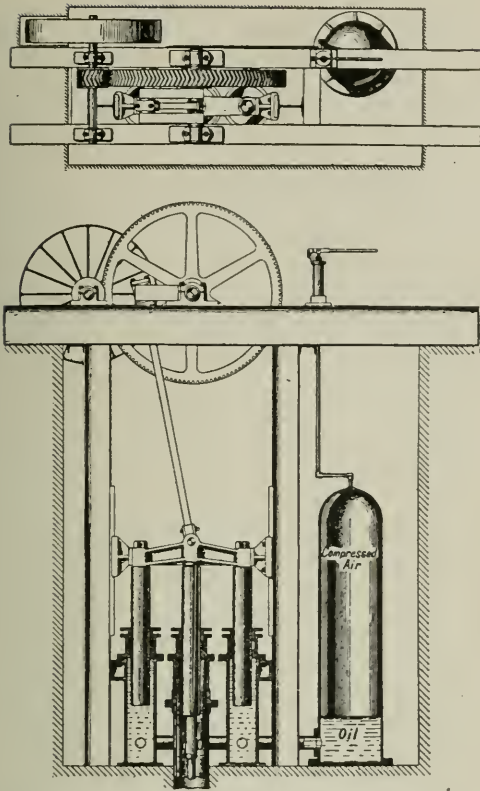
Fig. 8, from *Engineering and Mining Journal*, shows a pneumatically operated ore chute door in use at the Cactus mine of South Utah Mines and Smelters, Beaver County, Utah. The door is operated by moving a lever controlling a four-way valve. The advantage of this gate is that the weight of the ore bears directly on the shaft so that the power re-

quired in opening and closing is less than in the old style of drop gate. The closing is positive and ore is not spilled on account of rock getting under the gate and preventing its total closure. To the bottom corner of the chute is attached the supporting shaft. The door is constructed of a square sheet of boiler plate the width of the chute, bent in an arc with the face up, and supported on the shaft by two legs, so as to revolve about the shaft as an axis. To the side of the door which is on the underside of the chute, is attached a piston working in a cylinder. The piston rod is hinged at top and the cylinder at bottom so as to allow the necessary play. The air pipe parts at a four-way valve and the air enters the cylinder from top and bottom.

Fig. 9, from *American Machinist*, is perhaps the most interesting of the group of devices here shown. The cylinder A was lined with babbitt and it was required that the entire surface should be peened or hammered to make it compact before boring. The cylinder was mounted upon the table of a horizontal boring mill, and the pneumatic hammer was mounted near the end of a special rotating bar. The air was conveyed to the hammer through the center of the bar and controlled by a valve, not shown, with which the hose connected. The bar was rotated slowly, the hammer delivering its rapid blows, and the table with the cylinder was fed along until the hammer reached the other end and the job was done.

THE FARMER'S BLOWER

The old stump puller is no more, the dynamiting of stumps is not a great success, and now the rotary blower is trying it. A small portable gasoline engine of one or two horsepower is used to drive a blower, from which pipe lines are run to various stumps. A portion of the earth is dug away from a stump, a fire is started, and when well under way a blast of air by one of the pipes is directed against it, and in a short time the stump, with roots included, is entirely consumed. A 14-inch blower will supply air for at least 6, and in most cases 8 and even 10 stumps. This outfit will clear under average conditions over half an acre per day and at a cost not exceeding \$5, which includes cost of gasoline, labor and other items of expense.



A COUNTER BALANCED DEEP-WELL PUMP

The cut here reproduced from *The Engineer*, London, shows a pneumatically and hydraulically balanced well pump recently installed in some English mines. One of these pumps is at present operating an 8 in. deep well and is working on a total water lift of 350 ft., 320 ft. being below the surface and 30 ft. above. It is electrically driven and has been running now continuously night and day, Sundays included, since September, 1911. A second pump has a similar water lift, while a third is of a larger capacity than either of the foregoing, being designed to raise 12,000 gallons of water per hour on a lift of 250 ft. below and about 30 ft. above surface level.

The top portion of the pump is operated by a crank driven by helical gears. The motive power can, of course, be applied direct or through a belt. The single crank operates, by means of a connecting-rod, a

cast iron crosshead which works in adjustable slipper guides. To this crosshead are attached three plungers, of which that in the centre works a tier of pump rods.

The two side rams work through stuffing-boxes fitted with metallic packing, the pressure on the rams being maintained by a cylinder filled with compressed air, there being the necessary connecting pipe between the plunger barrels and the cylinder. In order to obtain a seal the lower portion of the cylinder is—as will be observed in the engraving—filled with oil.

By means of this arrangement a variable counterbalance can be obtained to suit exactly the pumping water level, this being brought about by varying the air pressure in the cylinder. The advantages which are claimed for this system of counterbalancing are as follows:—(1) Silence in working; (2) the obviating of wear and tear in the working parts; (3) adjustability of counterbalance by a variation of air pressure; (4) the relieving of the crank shaft of over half the weight, as half the pull of the pump is taken up by the plungers, the weight of which is all carried on the floor or bottom of the pit; (5) even turning moment, the variation of speed when passing over the top and bottom centres being eliminated; consequently (6) elimination of back lash in the gear wheels; and (7) that owing to there being a certain amount of thrust on the down stroke the work is considerably more even on all the bearings than is usually the case, the load on the crank shaft being equalized during the complete revolution.

It has been found in practice that the air in the air vessel requires only a few strokes of the compressor about once a week to maintain the required pressure, while, owing to the type of packing employed, the oil only requires replenishing about once a year.

OUR COAL

The known coal area in the United States covers 310,000 square miles, and there are 160,000 square miles additional which may contain marketable coals and 32,000 square miles which are not available. The original content of these coal measures is estimated

at 3,076,204,000,000 short tons, of which 1,922,979,000,000 short tons are easily accessible; 1,153,225,000,000 short tons are accessible with difficulty. The production from these coal measures to the end of 1911 was 2,270,798,737 short tons of anthracite and 6,468,773,690 short tons of bituminous, an aggregate of 8,739,572,427 short tons. This production represents an exhaustion of the coal beds equal to 14,181,890,000 short tons, or a little less than 0.5 per cent. of the original supply. The quantity of coal yet available for mining is 3,062,022,020,000 short tons, or about 99.5 per cent. of the original supply.

CARE AND LUBRICATION OF AIR COMPRESSORS

The following has been prepared by Mr. James L. Davidson, Secretary of the Alabama Coal Operators Association, under the approval and direction of the Mine Casualty and Mining Institute Committee.

Having noticed in the Alabama Supreme Court Reporter a decision, awarding heavy damages to the Administrators of a man killed in the mines by gas from the exhaust of a compressed air driven pump, when he went to start up the pump; the Secretary takes the liberty of giving you the following information, gathered from reliable sources, in regard to the care and operation of Air Compressors, with respect to safety and efficiency, viz.:

It is a fact that Air Compressors frequently pollute the mine air with dangerous gases, and sometimes explode, causing damage to persons and property. In either case the same may be generally attributed to the excessive heating in the presence of compressed air of the oil and foreign substances that have collected in the cylinder, discharge pipes and air passages and especially in and around the valves. Volatilization and ignition of oil and other carbonaceous matter occur very rapidly in the presence of highly heated air.

The greatest heating takes place where the air passes from the cylinder into the discharge pipe.

Even though the compressor is equipped with modern and approved cooling devices, insufficiency of size or too many angles in the discharge pipe, or incrustation of dust

mixed with oil, at the discharge opening, decreasing the capacity of the discharge any or all of them may produce enough heat to cause an explosion, or anyway, produce dangerous gases, which should not enter the mine.

TWO IMPORTANT THINGS.

It is therefore, important:

First—To Keep the Compressed Air While Being Compressed, At As Low A Temperature As Possible.

Second—To Prevent Oil and Other Carbonaceous Substances From Collecting in Any Part of the Machine Or in the Discharge Pipes.

All ports and air passages should be as large as practicable and should be kept free from obstructions and incrustations. In addition to partly closing the ports, incrustation often causes the valves to stick, resulting in disastrous consequences. When the valves stick it causes a "Back kick" and considerable friction in re-compression, which produces great heat.

To avoid incrustation and collecting of oil and foreign substances in the machine and discharge pipes, high-grade non-carbonizing oil may be used and should be properly fed into the cylinder. Petroleum oil, especially free from volatile carbon, with flash point of not less than 625 degrees F. is recommended. The oil should not be too dense nor contain animal or vegetable oil. Do not in any case, use ordinary steam cylinder oil. Why? Because the heat in the Steam Cylinder is moist, and the surplus oil is washed out, whereas, the heat in the Compressor Cylinder is dry, thus causing the oil to stick and cake. For the above reason, and also on account of the difference in the character of the proper lubricant and the work it has to perform, the proper feeding of oil, to the compressor cylinder, is very different from the oil feed to a Steam Cylinder. Too much oil causes incrustation. A surprisingly small quantity of good oil will give sufficient lubrication to air compressors. Watch your compressor and cut the amount of oil down to the minimum of its requirements. Oil should not be allowed to collect in the machine. In case it does, it should not be allowed to remain, but should be drawn off immediately.

Even when using the best oil, properly

fed to the cylinder, the machine should be cleaned frequently or when needed.

DON'T USE KEROSENE.

Do not use kerosene for cleaning! It is very dangerous. Kerosene has a flash point of about 120 degrees F. and the temperature of the compressed air may at any time reach 300 to 450 degrees F. and cause an explosion. The best and safest method of cleaning is to feed into the air cylinder, soapsuds, made of one part soft soap, to 15 parts clean water. Feed a liberal amount of this solution into the cylinder instead of the oil for a few hours or even for a day, if necessary. The accumulation of this water and oil should be drained off from time to time during the process by opening the blow off valve at the receiver.

To prevent rusting, it is necessary to run the machine and feed oil into the cylinder for an hour or so after the cleaning process is completed and the water drained off, so that the valves and all parts connected with the cylinder will become coated with oil before shutting down the machine.

The temperature of the discharged air should never exceed 250 degrees F.. The machine should be watched and if the temperature exceeds the above, it should be shut down and cooled. If possible, the cause of overheating should be eliminated before starting up again.

The temperature increases as the pressure increases, therefore, it would be well to equip all air compressors with automatic pressure or temperature regulator, which will allow the compressor to run idle as soon as the pressure or temperature in the receiver reaches a predetermined limit and likewise bring the compressor into action again as soon as the pressure or temperature falls below this limit. There are regulators on the market which apply to compressors coupled direct to the engine, or driven by electric motors, or driven by belt and pulleys.

As an extra precaution, a fusible plug may be placed in the discharge pipe near the compressor. This plug should be constituted to fuse and blow out at a temperature of between 325 and 350 degrees F.

Remember that proper construction, proper care of the machine and high-grade lubricants, may save life and are cheaper than

shut downs, lost power, destruction of property and damage suits!



A FUSIBLE ALARM PLUG FOR COMPRESSED AIR APPARATUS

The half tone above shows a fusible signal or alarm plug which requires practically no explanation to any one who reads the article immediately preceding. When everything is going all right in compressor, receiver and piping this device will have nothing to do but to stand and wait. Safety in compressed air practice is largely dependent upon the maintenance of normal temperatures. As is well known higher temperatures, with dangerous accompaniments, occur, and if not at once attended to explosions follow, or the air delivered is vitiated, with such consequences as that mentioned in the opening paragraph.

In the case where the man was killed by the products of combustion coming from (presumably) the air receiver, if this little plug had been on guard it would have given a warning whistle, the compressor would have been stopped and accident would have been averted.

In the use of this plug a $\frac{1}{4}$ in. pipe hole is drilled and tapped at the point or points where the high temperatures originate, the plug is screwed in and left there permanently and it will do the rest. The device contains a fusible insert which melts at a fixed predetermined temperature and when this temperature is reached, from whatever cause, there is a free escape of air which, rushing out of the holes in the cap, makes such a noise as compels immediate attention. When everything is all right again it is a simple matter to replace the fusible insert with a new one and the machine is again properly protected.

The melting points provided are 350 degrees and 500 degrees respectively. The first

of these is suitable for use in the discharge pipe of a single-stage compressor working up to 40 lb., in the discharge side of a two-stage compressor working up to 100 lbs., or in the discharge side of a three or four-stage machine delivering air at 1,000 lb.

The 500 degree plug is for use in the discharge pipe of a single stage compressor working at 100 lb.

Each plug is sent out with 6 extra fusible plugs or buttons and these can be supplied as numerous as required. The device is known as the Hodges Fusible Air Signal Plug. Ingersoll-Rand Company, 11 Broadway, N. Y.

APPLICATIONS OF THE SANDBLAST TO GOLD AND SILVER INDUSTRIES

BY FRANK MASON.*

The continued demand for variety in the finish and appearance of gold, silver, and electro-plated goods, gives to the sandblast such a wide field of operation as to be almost unlimited, and the opportunities, now opening up, for its application are without parallel in its history. As a ready means of imparting to silver and other surfaces, at a small cost, a finish, very pleasing to the eye, it is hard to rival. Sandblasting is by no means new, and has been in operation a considerable number of years, but its usefulness in the above mentioned direction would appear to have been either neglected or unnoticed in many manufacturing, where it might be employed to great advantage. Its use, of course, is not merely confined to silver and gold, and when viewed from the broader field, its applications are extremely wide, being utilized for a number of purposes in the glass, china, iron and steel and other industries. No attempt, however, will be made here to describe its connection with these latter processes.

In contrast to the blasting required for gold and silver, that for iron and steel is very coarse and is applied very often for cleansing purposes. This, of course, would be totally unsuitable for the majority of articles plated with, or composed of the nobler metals. From the number of machines specially built for dif-

ferent classes of work, constantly being placed on the market, it would seem that blasting machine manufacturers are alive to the possibilities of their productions. These are now so numerous that to select the most suitable would be almost impossible without first being acquainted with the class of work to be done. In view of this fact, it is the intention of the writer to guide the would-be sandblaster in this selection, by a description of the conditions which exist when imparting to gold, silver and electro-plate a variety of finished surfaces. Briefly expressed, the process of sandblasting is one which consists essentially in forcing a stream of sand or other abrasive material against a metallic or other surface for the purpose of altering its characteristic appearance. The two chief governing factors of the process are, the pressure and the material used. Obviously, therefore, the method of procedure may be varied in two directions.

1. By varying the pressure used in forcing the blasting material against the article.

2. By using material with varying cutting properties and of different grain.

A matte may be obtained in the former case, which is very deep or slight, but not necessarily coarse, even under a pressure of 18 to 20 pounds per square inch. This factor (the power), then governs to a large extent the depth of the matte and varies between about 2 to 20 pounds per square inch, according to class of work, and desired ultimate appearance. The question of blasting material is one of undoubted importance and yet strange to say, is very often overlooked. It is not uncommon to find practical sandblasters of from 15 to 20 years' experience having used sand only and that in perhaps only two grades.

Some time ago it was the writer's privilege to visit two large English sandblasting works and in both cases the above mentioned conditions obtained, and the only means of imparting a relative fine or coarse matted surface was to increase or decrease the pressure. A visit to a continental plate and jewelry establishment would very quickly convince the sandblaster laboring under these conditions, of the obvious difficulties he would encounter in endeavoring to produce such surfaces as he would see displayed in a first-class house. The peculiarly frosted, delicate, French grey finish so dear to the artistic Parisienne, and to be seen all over the continent is a striking

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example of the careful manipulation and the delicate treatment necessary in some sand-blasting operations. In this class of work this process is the last to which the article is submitted, hence its requirement of very careful treatment, judicious selection of blasting material and well regulated low pressure.

This finish is very often seen on silver toilet mounts and jewelry, but of course can be and is imparted to larger surfaces. The article, when ready is "Oxidized" by means of antimony chloride, relieved when necessary, and then blasted with finely powdered pumice at a pressure not exceeding 3 pounds per square inch. It will be obvious that to use a much higher pressure and coarse grained material would spoil the work put into the article just prior to this operation. The article is then washed out as if finished on the polishing wheel, or by hand.

Another instance in which very careful manipulation is required is in the production of the lovely, soft, greenish gold tint so much admired. This is obtained on gold-plated articles, as well as those manufactured wholly from the metal itself. Here again under even a moderate pressure from the sandblast, the deposit of gold would be completely spoiled. The method adopted in most cases to obtain the above finish is first to gild or gold-plate the articles, bringing them from the gold bath a little darker in color than is required in the finished appearance. If heavily coated, scratch brush, preferably with very fine German silver wire brush, and blast with flour of pumice under a pressure not exceeding 3 pounds per square inch. Wash away any pumice clinging to the article and wipe with very soft chamois leather. The resultant finish will be one which finds favor with the buyer of delicate jewelry, etc.

While discussing gold and gold-plated goods, it should be pointed out that almost all kinds of material used in blasting are also used in this connection. The difference in the above described process and those to which the reader is now referred being, that while in the former instances the blasting is the last operation, in the latter it is blasted just before being plated. In selecting the material and pressure to be used, the operator must be guided by the desired ultimate finish. For instance, in some cases a somewhat dull and exceedingly fine matted surface is required.

A pressure of 8 to 10 pounds per square inch with finely divided pumice as blasting material will give this appearance. Then again, it is often required to produce on silver and gold a similar matte but bright. In this case substitute powdered glass for pumice.

A very fine surface appearance, usually employed on articles having parts in high relief, is obtained by means of the sandblast on "Oxidized" silver as follows:

The process of sandblasting should be operated just prior to silver plating using powdered pumice and a pressure of about 12 pounds. After completing the deposit, "oxidize" same in a solution of potassium sulphide until the article assumes a rich deep blue, or blue black color. Then by means of a calico mop or dolly and Trent sand, relieve where necessary according to design. The result of this process is quite a study in light and shade and is productive of some very fine effects. Satin finish, now often produced by means of the sandblast, is a term used to indicate the appearance of articles bearing a matted surface. This definition of the particular finish referred to, is perhaps the safest one to give on this occasion as the term is applied by different persons with "satin finish" ideas varying from coarse to very finely matted surfaces, and all grades between these two. The method which is found to be most satisfactory is to employ a pressure of about 14 pounds per square inch, using as blasting material a medium grain Calais sand, previously sifted. It may be well to mention that these conditions obtain in the majority of instances where table plate, etc., is required to have the matted surface throughout. The articles are then silver or gold plated by the ordinary method, if necessary.

Crystalline, ice-like surfaces similar to some molded glass wares, are sometimes desired. It is necessary in these cases to employ a high pressure, say 18 pounds per square inch. As blasting material, a coarsely ground glass or very coarse sand should be used. This, of course, is done before plating, and as it is quick and severe in operation must not be overdone by prolonged blasting. "Partial frosting," as the term suggests, is the production on one surface of a combination of matted and brilliantly burnished parts.

This gives to the article a very pleasing contrast and is imparted thereto by means of

the stencil. It may be accomplished very readily by cutting from ordinary writing paper or similar material the pattern or parts to be left bright or burnished, and then glue same to the article. Allow to set thoroughly, and sandblast unprotected portions. The glued paper is easily removed by suspending the article in hot water. Subsequent processes, such as plating, etc., may then be proceeded with.

To obtain the necessary pressure in all the foregoing operations, either compressed air or steam is used. In selecting the more suitable power for any specific work, it is well to bear in mind that if powdered pumice is intended for use steam pressure is out of the question, because, as the steam condenses it often impedes and eventually stops the action by clogging the course with wet pumice. Referring to the initial costs of the two systems, one is bound to say that steam pressure is the cheaper, generally. Of course, where compressed air is ready at hand, the above statement does not apply. If, however, matted surfaces much finer than the generally accepted satin finish is desired, then the operator will be well advised to install compressed air plant, although the cost may be greater.

MEASURING AIR DISCHARGE OF COMPRESSORS

BY E. A. FESSENDEN.*

This is a brief account of a method of measuring the volume of air delivered by a compressor which the writer has often successfully employed.

Only one tank is required and this may be the receiver tank which often forms a part of the compressed-air equipment. If such a receiver is not a part of the equipment, any reasonably tight tank will answer the purpose if it is strong enough to hold the normal delivery pressure of the compressor safely. A few small leaks will not affect the results in any manner whatever.

The arrangement of the tank is shown in Fig. 1. The outlet pipe contains a tee for a thermometer cup *T* and two valves *A* and *B*. A carefully calibrated gage is provided to read the pressure of the air in the tank. If the regular receiver is used the outlet pipe

may be the ordinary service pipe, but when a test is to be made it must be disconnected from the service lines so as to discharge directly into the atmosphere through the two valves *A* and *B*. There should be a valve between the tank and the compressor. All other outlets from the tank should be closed off.

When ready for a test, first open valves *A* and *B* wide. Then with the compressor running at its usual speed gradually close valve *B* until the pressure in the tank remains constant at the normal working discharge pressure of the compressor. The compressor will then be running under normal operating conditions. After allowing the compressor to run in this condition for a short time to insure that all conditions have become constant, close valve *A* tight and allow the pressure in the tank to rise to 10 or 15 lb. above the normal working pressure. Then close the valve between the tank and the compressor and stop the latter.

Open the valve *A* quickly and take simultaneous readings of time and pressure as the pressure in the tank falls due to the escape of air through the valve *B*. The best way to do this is to have an assistant hold a watch and call "read" at uniform intervals of 15 or 30 sec. The exact pressure should be read at the instant the signal is called. Continue this until the pressure has dropped considerably below the working pressure.

Plot the readings just taken on cross-section paper so as to obtain a curve of pressure against time as illustrated in Fig. 2.

From the thermodynamics of gases we have the general equation for any gas,

$$PV = WRT \quad (1)$$

in which

P = Absolute pressure in pounds per square foot;

V = Volume of gas under the pressure *P*, in cubic feet;

W = Weight of gas present in pounds;

T = Absolute temperature of the gas in deg. F.;

R = Constant = 53.35 for air.

Equation (1) can be rewritten as

$$\frac{PV}{RT} = W \quad (2)$$

In the case under consideration *W*, *P*, *V* and *T* represent the weight, pressure, volume and temperature of the air in the tank at any time.

*Associate Professor of Mechanical Engineering, University of Missouri.

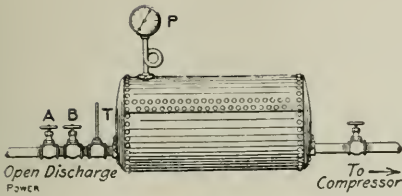


FIG. 1. AIR TANK FOR MEASURING DISCHARGE

The volume and the temperature remain constant and the pressure and weight decrease as the air escapes through the partly open valve *B*. The volume considered is the entire volume of the tank and all connections between valve *B* and the valve between the tank and compressor. This can be determined by filling the tank and connections with water, weighing the water required and calculating the volume by dividing by 62.355, the weight of 1 cu.ft. of water at 62 deg. F.

Differentiating equation (2) with respect to time gives

$$\frac{dW}{dt} = \frac{V}{RT} \times \frac{dP}{dt} \quad (3)$$

in which $\frac{dW}{dt}$ is the rate of decrease of weight of air in the tank, or in other words, the rate of discharge, in pounds per second, while $\frac{dP}{dt}$ is the rate of decrease of pressure.

In Fig. 2 let *M* be a point on the pressure-time curve corresponding to the normal working pressure of the compressor. Draw the line *MN* tangent to the curve at *M* (this must be done carefully). Draw the line *MK* parallel to the pressure axis. Then

$$\frac{dP}{dt} = \frac{MK}{KN} \quad (4)$$

The values of *MK* and *KN* are read in pounds per square foot and seconds directly from the figure.

If the value thus obtained for $\frac{dP}{dt}$ is introduced into equation (3) the rate of discharge in pounds per second is found directly. Since the weight discharged must be the same as the weight drawn into the compressor, the free air capacity is found by the formula

$$V_o = \frac{WRT_o}{P_o} \quad (5)$$

where V_o is the volume in cubic feet of air per second at the intake pressure P_o (in pounds per square foot absolute) and at the absolute temperature T_o , and W is the weight of air discharged per second just found from equation (3).

To illustrate this method consider Fig. 2 to be the pressure-time curve of a small compressor delivering air into a tank which with its connections has a volume of 47.7 cu.ft. The temperature of the air in the tank at the time the test was made was 87 deg. F. or 547 deg. abs. It was desired to find the amount of air discharged against a pressure of 56 lb. per sq.in. abs. Thus the line *MK* represents 56 lb. per sq.in. or 8064 lb. per sq.ft. From the figure *KN* is 194 — 20 = 174 sec. Then

$$\frac{dP}{dt} = \frac{MK}{KN} = \frac{8064}{174} \text{ lb. per sq.ft. per sec.}$$

From equation (3)

$$\frac{dW}{dt} = \frac{47.7}{53.35 \times 547} \times \frac{8064}{174} = 0.0758 \text{ lb. per sec.}$$

At atmospheric pressure and 32 deg. F. the volume of air passing into the compressor is

$$V_o = \frac{WRT_o}{P_o} = \frac{0.0758 \times 53.35 \times 492}{14.7 \times 144} = 0.9391 \text{ cu.ft. per sec.} = 56.346 \text{ cu.ft. per min.}$$

When accurate results are required, it is well to repeat readings for the pressure-time curve several times and take the average value of $\frac{dP}{dt}$

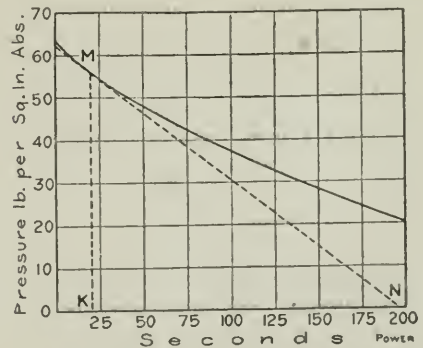


FIG. 2. PRESSURE-TIME CURVE

— thus obtained. It is, of course, important that the pressure gage and thermometer used be carefully calibrated, and that the temperature of the air remain the same when the readings for the pressure-time curve are taken as when the valve *B* is adjusted. After once adjusting valve *B* it must not be disturbed until the test is finished.

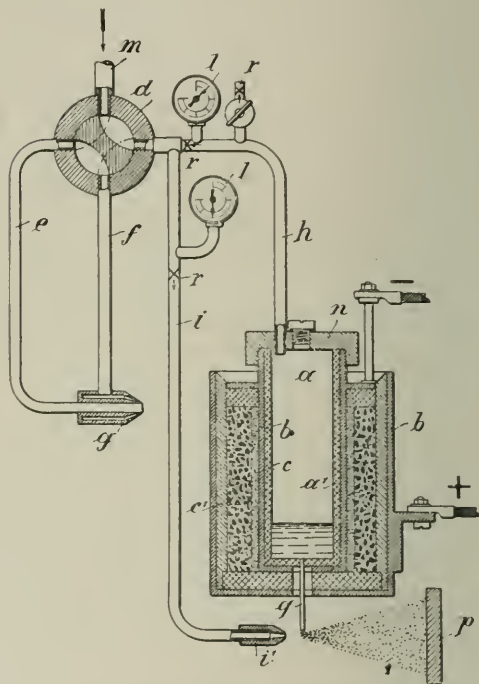
This same scheme can be used to provide a constant load on a compressor for an economy test. It is only necessary to adjust the valve *B* to give the discharge pressure desired and then run the compressor continuously at the proper speed, allowing it to discharge into the tank and the air escaping through valve *B*. As long as the pressure and temperature of the air in the tank are constant the rate of discharge is constant. The compressor governor should be adjusted to keep the speed constant and the pressure will remain constant as long as the valve *B* is unchanged. The temperature of the discharged air is practically dependent upon the amount and temperature of the jacket-cooling water. If these are kept constant the air temperature will not change appreciably. The compressor is then allowed to warm up thoroughly so that all these conditions become constant and the test is begun by adjusting valve *B*, thus fixing the rate of discharge as determined from a pressure-time curve. The load will now remain constant and the readings of steam pressure, steam weight, indicated horsepower, etc., are taken in the ordinary way.

The method outlined above has several advantages: It is rapid, simple, practically and theoretically correct and can be made very accurate if care is taken in making the readings and in plotting the pressure-time curve. It is flexible and can easily be adapted to widely different conditions of operation. All leakage and friction losses are taken into account. No expensive apparatus is required and often not even a change in piping. The manipulations and calculations are easy.—*Power.*

SPELLERIZING

For small sizes of pipe a process, known as "spellerizing" has been developed by the National Tube Co., to give a uniformly dense surface to steel piping adapted to resist corrosion and pitting. This process consists in running the heated bloom through

rolls, having projections on their working surface, then running the bloom through smooth faced rolls and repeating the operation, thus kneading the surface and compacting it. The process is applied to pipe 4 in. and under, although it can be used in special cases for pipe a few sizes larger than 4 in.



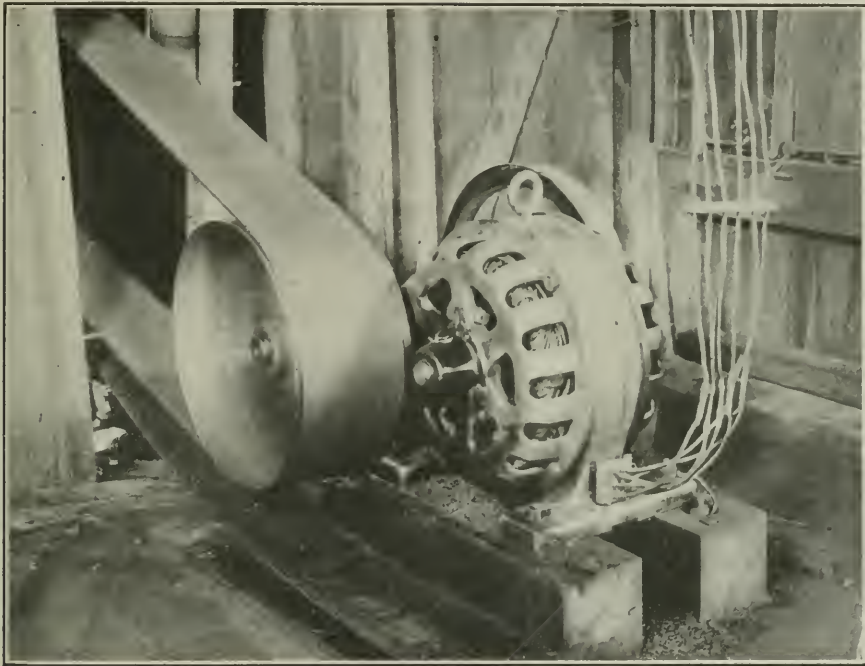
MAKING METAL POWDERS

The cut is a sketch of an arrangement, recently patented in France by M. Schoop, for producing powders of metals, such as lead, tin, zinc, etc. The metal to be powdered is melted in an electric crucible *a*, flows out through the small tube *q*, and as it emerges it is struck by a forcible blast of air from the nozzle *i* and driven against the plate *p*, this operation reducing the metal to a fine powder.

Compressed air is responsible for the entire operation. The air is led from the compressor by pipe *m*. With the four-way valve *d* in the position shown there is air pressure upon the surface of the molten metal in the vessel *a*, and air also flows down pipe *i* to the nozzle *i*. The valves *r* provide the means for differentiating the pressures in the two pipes, that for the blowing nozzle being required to be the greater. Upon the

proper adjustment of these relative pressures much of the success of the operation may depend. When the four-way valve is turned to the position shown by the dotted lines compressed air flows through pipe c to the ejector g, which creates a partial vacuum in pipe f, which then communicates with pipe h and the vacuum not only holds up the metal in crucible a, but draws it up so that it will not solidify in pipe q.

The change in speed is accomplished by changing the number of poles. The stator of the motor is provided with two windings, one of which gives 6 poles with a speed of 1,200 rpm., and the other 12 poles and 600 rpm., the connections from one set of windings to the other being made by the controller. The motor can thus be operated at the low speed at its highest efficiency,



TWO-SPEED MOTOR FOR FAN DRIVE.

A TWO-SPEED A. C. MOTOR FOR A MINE FAN DRIVE

The halftone illustrates a special adaptation of electricity to mine service. It shows a two-speed alternating current, three-phase, 60 cycle, 440 volt motor belted to a 12 foot Guibal fan installed in the Greensburg No. 1 mine of the Keystone Coal Company.

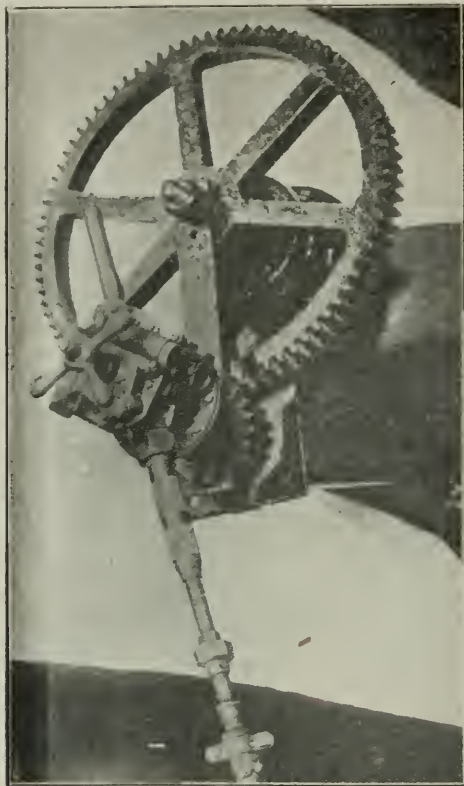
The force of miners is considerably less at night, and consequently it is then desired to run the fan at only about half the speed. To satisfy the requirement there was selected a Westinghouse CCL squirrel-cage type induction motor with a rating of $7\frac{1}{2}$ horsepower at 600 rpm. and 15 horsepower at 1,200 rpm.

there being no losses in the control resistance.

Current for the operation of this motor is furnished by the West Penn. Electric Company. To determine the results tests were made by Mr. C. V. Elliott, electrical engineer of the Lighting Company.

The fan is 5 feet, 6 inches wide, and the blades 3 feet, 6 inches deep. When running at 120 rpm., with 1.5 inches water gage, 46,200 cubic feet of air per minute were delivered. The motor took 9.6 kw., giving an efficiency of 63.03 per cent. When running at half speed, or 60 rpm., with .8 inch water gage, 14,850 cubic feet were delivered with an efficiency of 58.53 per cent. These

results are important as they show economy in the use of purchased power, which is becoming the standard practice where alternating current is available.



AIR MOTOR FOR WATER GATE.

OPERATING GATE VALVES BY COMPRESSED AIR

A compressed air motor equipment for operating large valves in water mains, shown in accompanying illustration, is used on four large valves in the Sacramento waterworks, and, it is said, will open a valve in 2 minutes where it formerly took two or three men 10 minutes. The size of the gear, which meshes with a 4-inch pinion, is 24 inches.

This device was invented by Louis D. Ehret, chief engineer of city waterworks, Sacramento, Cal. It may be attached to a valve with little difficulty and used for opening and closing it. The valve shown in the illustration is a 30-inch suction valve of the 10,000,000 gallon Snow pumping engine.

Engineer Ehret first intended to operate the

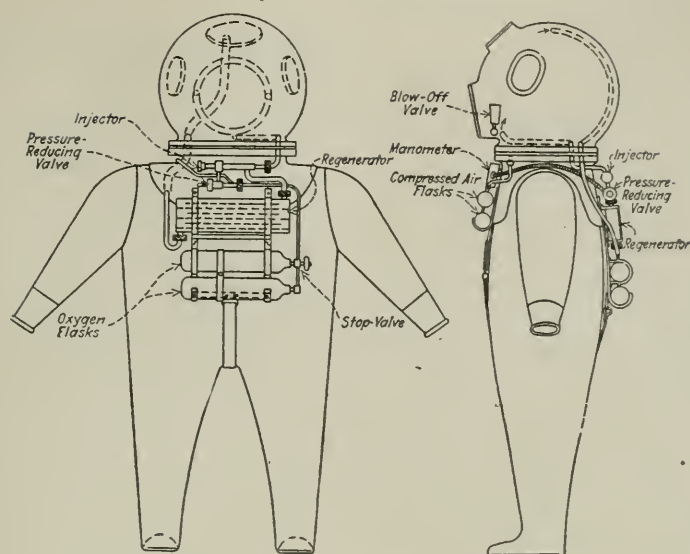
valve with an electric motor, but it was found that the expense of the motor and power would be too high. He then changed the power to compressed air.

As there is an 8-inch pump operating in the plant to fill the air chambers on the pump, all that was necessary to do was to install a receiver and rig up the gears. With this arrangement the opening and closing of the large valve is performed in a most satisfactory manner, besides being a great saver of time and hard work.—*Insurance Engineering*.

[The above is interesting, but the device has scarcely the novelty here claimed for it. Many gate valves in the water service of New York City are operated by compressed air motors of the "Imperial" type. Editor C. A. M.]

AIR SHOULD BE COOL AS WELL AS "FRESH"

Prof. J. B. Lock gives some interesting particulars of experiments that have been carried out at Cambridge during recent years in connection with the heating and ventilation of large lecture rooms and halls. Various systems have been tried, and have led to the conclusion that a crowded room should not be warmed by heated air; the fresh air supplied for breathing should be cooler than the air in the room, and the room should be warmed by other means. A large hall seating 1,000 persons is heated with hot-water radiators near the walls at the floor level, and fresh air is introduced by fan through two rows of gratings 8 ft. or 9 ft. above the floor level; an exhaust fan withdraws the air through openings in the ceiling. Two years' observation has established the fact that the cooler the fresh air sent in, the more pleasant is the atmosphere in the hall: when the hall is full it is difficult to obtain air cool enough, even when the outside temperature is 40 deg. Fah., and the installation of ice coolers is under consideration. In the case of laboratories warmed by hot air, which is passed over heating pipes, the oppression and discomfort experienced by the occupants are much greater when steam heating pipes are used than in the case of hot water pipes, and it appears that "cooking" fresh air destroys its invigorating qualities.



SELF-SUPPLYING DIVING APPARATUS.

AN INDEPENDENT DIVING APPARATUS

For this abstract here presented we are indebted to the Foreign Review department of the monthly Journal of the American Society of Mechanical Engineers. It is taken from *Glückauf*, Sept. 7, 1912.

By invitation of the German Navy Office several firms have endeavored to construct a *diving apparatus without air pipe*, such as might be used by the crew of a submarine in case of accident. The present article treats of one by the Westfalia Armaturen- und Maschinenfabrik in Gelsenkirchen, Germany. Both factories had, previous to the construction of diving apparatus, a large experience in the manufacture of similar apparatus for miners and firemen. As shown in the cut the diver carries on his back a regenerator tank taking care of carbon dioxide and water vapor from breathing, while below it are steel flasks with gas for breathing. This gas is not pure oxygen, which is poisonous when at high pressure, but a mixture of oxygen and compressed air in such proportion that even at a depth of 50 m (164 ft.), corresponding to a pressure of 6 atmospheres absolute, the content of oxygen does not exceed 23 per cent. Various ratios of the mixture are used for

work at various depths; thus, for 20 to 30 m (65 to 98 ft.) 45 per cent. oxygen and 55 per cent. nitrogen, while for depths from 50 to 60 m (164 to 196 ft.) 30 per cent. oxygen and 70 per cent. nitrogen. The oxygen and air or nitrogen are not kept in separate vessels, but the flask is first filled with compressed air up to a certain pressure, and the oxygen is then pumped in, special tables being used for the determination of the pressure corresponding to certain percentages of oxygen in the mixture. The pressure-reducing valve between the steel flasks and injector is so arranged as to vary automatically the amount of gas admitted in proportion to the water pressure, the diving outfit being thus always filled and permitting of easy and comfortable breathing. The compressed gas mixture serves also to drive the injector which, with the help of suitably arranged piping, takes the vitiated air from the upper part of the helm and returns it thither after it has passed through the regenerator and becomes free of the carbon dioxide and moisture. On the front side are placed two flasks with compressed air, to be used for rapidly filling the diving suit when the diver wants to come to the surface quickly. The manometer permits him to see what supply of air and oxygen he still has at his command.

THE PNEUMATIC TIRE WITHOUT A RIVAL

BY J. D. ANDERSON *

It used to be the fashion among inventors to periodically announce a new and deeper probe into the abysmal depths of the mystifying problem of perpetual motion. To do this was considered good style. Obviously styles change among inventors as well as among ordinary mortals. Just at present they appear to have dropped perpetual motion like a hot potato. What they're now trying to figure out is a substitute for air and rubber in the manufacture of automobile tires.

These days it's a poor inventor indeed who hasn't concealed about his person a blue print drawing or a working model of a patented wheel or tire that is destined to knock the everlasting daylights out of tire trouble. A few thousand or so patents covering such inventions have been issued by the United States Government. Promoting companies by the score have been formed; with persistent frequency startling announcements regarding the efficiency of some new discovery in the patent wheel line are scattered broadcast. And yet, with the automobile in a state of development approaching perfection, no one has been able to invent anything that could satisfactorily and permanently take the place of air and rubber.

The reason for this is that in their own particular line air and rubber are doing about all any reasonable person could expect them to do. Many experts, thoroughly conversant with every detail of the situation, maintain that the automobile never will rest satisfactorily on any other footing. Others, perhaps equally well informed, are not so sure that this is a fact. But of one thing we are all sure. That is that up to the present time nothing practical has been created to supplant such a highly resilient substance as rubber in conjunction with compressed air, in providing a foundation for the motor car.

The duties of an automobile tire are more exacting than the casual observer may imagine. Perhaps the first quality to be taken into account is that of endurance. A

tire must be so constructed and made of such materials that it will yield a satisfactory mileage return on the cash investment. This question of mileage service is the one which appeals with particular force to the car owner. However, there are other tire essentials, which, while probably not so conspicuous, by their presence, would be decidedly conspicuous should they be eliminated by the tire manufacturer.

Resiliency is an important feature of the pneumatic tire. This is the quality that absorbs the shocks of the road, furnishing easy riding not only to passengers, but protecting the engine and mechanism of the car as well. Without resiliency, a tire cannot perform some of its most important functions, and the whole structure of the motor car suffers in consequence. It is in the lack of this element of resiliency that most of the patented substitutes for air and rubber fall down. For easy riding and for affording complete protection to all parts of the car pneumatic tires, at least up to the present time, stand supreme.

The tires of an automobile must withstand all the force and impact of the engine in starting, driving, and stopping the car; they must carry weight, resist wear, withstand the heat generated by friction with road surfaces and the resistance of the brakes in stopping the car. Furthermore, they must be so constructed as to permit of quick removal and ready substitution. All of these qualities pneumatic tires, as they are made under our advanced methods of manufacture, possess. The only argument against them is that they will puncture and they will wear out. However, no substitute has yet been offered which combines all of the advantages of the pneumatic tire with greater lasting qualities at less cost.—*Evening Post*, New York.

APNEUMATIC INCIDENT

Bennie, aged 4, met Henry, aged 5, and the following conversation ensued:

"Whatsamatter your head?"

"Bumped it ona ceiling."

"Ona stepladder?"

"No, I was playin' 'ith my papa on a floor an' I was sittin' on his tummy."

"An' nen what?"

"Papa sneezed."

*General Sales Manager United States Tire Co.

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COMPRESSED AIR ELEVATING THE FOUNDRY

It is a curious fact that progress in mechanical industry does not proceed according to any well established laws, but that it seems to act in an irregular manner, some departments of work lagging behind, while others keep in the lead.

It has always been a matter for surprise that the foundry, until recently, has failed to keep pace with the machine shop, and even to-day it is only in the more modern and better equipped shops that the department in which the castings are made is as far advanced as the department in which those same castings are finished.

To-day, however, the foundry is overtaking the other departments of the manufacturing establishment, and there is every reason to believe that the modern workshop is more nearly homogeneous than ever before, so far as character of equipment is concerned. The moulding machine, the overhead traveling crane, the industrial railway, the pneumatic rammer—these and other tools are fairly equal in capacity and value to the lathe, the planer and the milling machine.

When we consider the interdependence of the various departments of a manufacturing establishment, it seems strange that modern equipment did not enter the foundry earlier than it has. The study of the influence of each element in a series of operations in sequence has emphasized what was well known before, even if imperfectly appreciated, that the final efficiency is found by multiplying together the several efficiencies of the successive operations. Since the product of the foundry entered into nearly all the other departments of an establishment, it is evident that an inefficient foundry formed a serious handicap upon all the departments which it served, so that any improvement effected could not fail to be far-reaching in its influence.

There is probably no one element which has aided more in the advancement of the efficiency of the foundry than compressed air. Whether in the operation of machines for ramming moulds, for operating hoists, for serving moulding machines, or for cleaning castings, the presence of a supply of air under pressure has placed in the hands of the foundry

dryman a source of power which has worked both for effectiveness and for economy.

Foundry work does not differ materially from other work in the extent to which the work of the brain may be supplemented by mechanical power. The skill of the hand is not inseparably connected with severe muscular exertion, although in many cases manual effort cannot be replaced acceptably by machinery. What can be done, and what is most effectively done by the use of compressed air, is to provide for the skilled hand such auxiliary power as will require only direction, and yet be at all times under perfect control.

Herein lies the demonstration, if demonstration be necessary, of the extent to which machinery which saves burdensome labor acts also to create further opportunities for skilled labor. When there is a greater demand for labor of a higher degree of skill, and when this demand is created by the introduction of apparatus which enables productiveness to be increased, we see that the ultimate effect of such appliances is to make more labor possible, while at the same time raising its character.

It is worthy of note that in operations in which mechanical power is substituted for manual effort the result is generally superior in quality to that formerly obtained solely by hand labor. This is doubtless due to several influences: the force at command is greater than could be exerted by the unaided hand, in addition to which the relief of the hand from the exertion of its full effort enables greater care to be given in guiding and regulating the mechanical power.

SAVED FEW DOLLARS—LOST THEIR LIVES

At Quincy, Mass., on January 1, at the granite yard of Reed & Vendret, an air receiver exploded causing the death of Mr. Reed and his brother-in-law, Mr. Lavoie. Some particulars of this "accident" have come to hand. The receiver was 6 ft. long and 4½ ft. in diameter, and had been in service at this yard five years. From its dimensions we are inclined to doubt whether it was originally built for an air receiver at all. It was bought second-hand with presumably the assurance that it was all right. It had previously stood upright for holding creosote. As an air receiver it was used hori-

zontally. What had been the bottom head began to leak in one place near the rivets. Four holes were drilled and a plate was put on inside and out, after which the air was pumped up to 75 lb., and then the explosion occurred, the plates being sheared from the head and doing the killing. The head, near where it is dished, ripped open about 18 in. and showed the bottom to be deeply pitted, these pits being about 1 in. in diameter, so that ¼ in. metal plate in one place showed a thickness—say rather a thinness—of ⅛ in.

This receiver was cheap in the beginning, if such a thing could be cheap at any price, but it was dear enough in the end. An air receiver should be one of the last things to buy second-hand, especially if its entire record cannot be known. Regular air receivers, especially those for the little plants, begin their existence with a minute factor of safety at the best. They are said everything cold and quiet, but as soon as to be tested by hydrostatic pressure with they get into service they may become very hot and subjected more or less to shock and where is that factor of safety then? The conditions of service favor the rapid rusting of the interior and rust is not a strengthening agent.

We have a brief account of another receiver explosion in Tennessee, as follows: "The shell of a 24x72 in. air receiver, carrying 90 lb. pressure, split from end to end in a straight line when the metal had wasted away to ⅛ in. in thickness, at the end where the rupture started." An hour before the explosion occurred this receiver could have been regarded as an excellent subject for a second-hand dealer to offer as a bargain.

NEGLIGENT COMPRESSED AIR PRACTICE

A paper having to do with air compressors and compressed air practice was read recently before the Manchester Association of Engineers by Mr. George Barr. The paper was offered with the idea of considering the reason why compressed air is accepted as an inefficient means of power transmission, as well as to show what had been done by manufacturers to improve this class of machine without any considerable pressure having been brought to bear on the subject by users. The author said that very inefficient plants exist, and exist in

large numbers, and are still being laid down. Why was this? Was it simply because it is thought nothing but inefficiency can be expected? Why not have the same strict specification applicable to air compressing plant as has been the rule for electric generating plant? The only reason which can be put forward why such a course was not adopted, would seem to be, taking a wide view of the matter, that few engineers had given much study to compressed air, and had taken it for granted that what had been, must still continue. We might look at the matter from this standpoint and see if the facts are as indicated. What did we find, in inquiries issued for large compressors? The capacity of machine was given, if steam driven, steam pressure and vacuum mentioned, if electrically driven, voltage. It might be, but it was not general, that steam consumption was asked, and on a very rare occasion a capacity test was called for. Such a test when made was seldom, if ever, any check on the output of the machine; the test generally being to fill a reservoir of given capacity from atmospheric pressure to final working pressure. The temperature of the air might be taken or might not, and when taken was generally misleading, and possibly allowed of error up to 10 per cent. It was questionable whether there was one compressor the actual capacity of which was known through a test.

UTILIZATION OF ATMOSPHERIC NITROGEN

The importance of nitrogenous compounds to the agricultural and industrial interests of Europe and America has prompted the Bureau of Manufactures to issue a monograph on the subject of utilizing atmospheric nitrogen in the production of such compounds.

The nitrogen problem, one of the most pressing of the twentieth century, is unique from the fact that the material is unlimited. The atmospheric nitrogen above one square mile of land, amounting to about 22,000,000 tons, is equivalent to what the world would require in the next fifty years at the present rate of consumption. The problem is to utilize this nitrogen economically, and thus free the world from its dependence on the nitrate deposits of Chile, which are not particularly extensive and are likely to be exhausted at a comparatively early date.

Remarkable results have been obtained in Norway by means of electric furnaces in which atmospheric nitrogen is oxidized to the form of nitric oxide, which is used in making calcium nitrate, or Norway saltpeter. This Norwegian product is already an important rival of Chile saltpeter, but as the success of the process depends upon a very cheap supply of electricity it will probably not be used to any great extent in the United States until the furnaces have been made more efficient.

Cyanamide, another nitrogenous fertilizer of growing importance, is being manufactured in America and the industry should prove successful, as the production in this country of the calcium carbide required by the process is second only to that of Norway.

The monograph describes in detail the results obtained by the leading European chemists in their efforts to increase the supply of nitrogenous compounds, and the commercial as well as the technical aspects of the new industry are dealt with at length. The author, Thomas H. Norton, consul at Chemnitz, Germany, on detail as commercial agent of the Department of Commerce and Labor, states in conclusion that the achievements of applied chemistry make it possible for American industry and agriculture to face with confidence the threatened exhaustion of the nitrate deposits of Chile.

TERRIFIC AIR BLAST CAUSED BY MINE COLLAPSE

The chief inspector of mines in India gives the following account of a destructive air blast which occurred recently at the Dhundabad coal mine of the Manbhoom Coal Company:

A violent blast, produced by an extensive fall of roof, dislodged a rail 11 ft. 6 in. long and weighing 52 lb., hurling it a distance of 32 ft. In its flight it struck a woman on her head and killed her outright. She was engaged in filling a car at the time when the roof fell.

The accident serves to bring into prominence the serious consequences to life and to the value of a mine which almost inevitably follow the leaving on "first working" of such small pillars that their ultimate crushing strength is but slightly greater than the pressure exerted by the weight of the superincumbent strata.

In a part of the mine where the cover varied

from 100 to 150 ft. and was composed of alternating shales and sandstones, the seam had been cut up into pillars some years ago. At the time of the accident these pillars ranged in size from 100 ft. square to 30 ft. square by 18 ft. high.

Pillar drawing had recently been started and 19 pillars had been extracted in the usual manner, when weighting of the roof began to assert itself in a mild form. The mine workers in that section were withdrawn and every precaution taken to protect those in other parts of the mine from being exposed to the effects of a sudden and dangerous development of this condition.

After the lapse of a fortnight a change took place and imminent collapse seemed certain. All the workers were removed from that side of the mine and told to work on the other side of No. 1 pit, 700 ft. away. This order was obeyed. That night the roof over the extracted area collapsed and so strained the adjoining roof that the pillars under it, numbering 103, were unable to withstand the added pressure and gave way, causing the roof to subside over an area of about 160,000 sq. ft. (four acres) and affecting the surface over a similar area, which resulted in damage being done to 57 huts.

Many persons in the mine were blown over and all the lamps were extinguished with the exception of one, by the aid of which the people found their way to the surface. Two men, sitting under the protection sheets of the shaft bottom, had a narrow escape.

Extensive pillar robbing had been practiced in the past and had so reduced some of the pillars that it was not safe to take them out. The fact that they had been much reduced in size assisted in the general collapse.

Large areas have been mined out in other parts of this mine. The subsequent falls have been confined to these areas and have not extended over the standing pillars. This, no doubt, led the manager to assume that the weight would be similarly restricted in this case also. The event, however, is one more proof that when pillars of small size are being drawn, sudden subsidence over an area exceeding the area extracted should be anticipated, and in such cases, all persons should be ordered out of the mine when the roof begins to show signs of collapse.

AIR LIFT EXPERIENCE

The company with which the writer is connected has, during the past seven or eight years, had in operation on the Pohle system 14 wells of an average depth of about 250 ft. These wells are in sand, interspersed with lenses of rather fine gravel. Some of the wells have 4, others 5, and others 6-in. discharge pipes, each having a 1¼-in. central air pipe. The water is found about 75 ft. from the surface, but, owing to the fine sand and gravel through which it must pass, there is considerable drop when the wells are pumping, the amount of drop depending upon the quantity of water pumped.

The lift at the different wells varies from 100 to 140 ft. Various submergences or heads have been tried from 60 to 35 or 40 per cent. of the total head and lift. The wells being in almost constant use in connection with the works have made the conditions very unfavorable for conducting a series of experiments or tests that would be of any particular value, but it is hoped that in the near future a favorable opportunity will offer.

As a means of obtaining a sufficient supply of water the wells have been a success, but from an economical standpoint per gallon of water pumped they have not been entirely satisfactory, and for this reason the writer some years ago undertook to work out theoretically the principles involved in the operation of the wells with the view of establishing the proper conditions for the most economical results. Formulas were deduced for determining the proper relation of head, lift, quantity of water, diameter of discharge pipe, quantity and pressure of free air required, etc., with the expectation of confirming or disproving them by actual test, but so far, for the reason stated above, without result.

In an article recently noted the following occurs: "Size of discharge pipe, gallons of water delivered per minute and ratio of lift to submergence remaining constant, the free air required per minute will be the same regardless of whether the lift is 10 or 100 ft."

This is at variance with theory, with the practice of engineers in figuring free air requirement, and also with the actual experience of the writer. Under the conditions as stated engineers figure the free air required would be proportional to the lift. Theoretically, the

free air required does not increase proportionally with the lift. The statement that "the cubic feet of free air per gallon of water raised increases as the ratio increases for a given size of discharge pipe, and for a given ratio it decreases as the size of the discharge pipe increases," agrees with theory. Also the free air required per gallon of water decreases with increased submergence, the lift remaining constant.

The statement that "a curve representing the horsepower per gallon of water raised for varying depths and constant lift will at first decrease as the depth increases until it reaches a minimum point, after which it increases" is not in accordance with theory. Theoretically, commencing at 10 per cent. submergence, the horsepower of the air required increases by a constantly decreasing ratio for each percentage of increase in the submergence. Economy in horsepower, therefore of fuel, lies in the direction of lower percentage of submergence, while economy in size of compressor plant, piping, etc., lies in the direction of increased percentage of submergence up to, say, 60 per cent.

For any given well the submergence, lift and quantity of water discharged being known, the proper diameter of discharge and air pipe may be found, and the whole adjusted to the most economical working condition.—*Iron Age*.

FILTERING AIR FOR CYANIDE PLANTS

Compressed air that is to be used for aerating the sand or slime, or in agitating the pulp is purified by filtration before use at many cyanide plants. Several types of filters are used; at the Homestake plants the air is passed through a filter press made up of several cells similar in all respects to the cells of the Merrill presses used in the treatment of slime. Cylinder oil or the products of its combustion or decomposition, which are introduced into the air in the cylinders of the compressors, are the impurities that should be removed as completely as possible before the air is used for agitating. The apparatus at the Alaska Treadwell has a further advantage in that carbonic acid is also removed by caustic soda or milk of lime. The removal of this acid is accompanied by a decrease in the consumption of

cyanide, for it is a well known fact that carbonic acid decomposes potassium and sodium cyanides, and even in the presence of an abundance of protective alkali some decomposition by this acid may take place.

NOTES

Consular Reports says that 35 million pounds of matches were exported from Sweden in six months. Why, that's 17,500 tons!

Nitrogen amounting to 810,000,000 tons has been wasted in the United States since 1893 through the use of the old-fashioned beehive coking oven. By-product coke ovens would have yielded from this coal 9,315,000 tons of ammonium sulphate, worth \$60 per ton, which could have been used as a fertilizer instead of importing \$15,000,000 worth of potash from Germany every year.

Steam is about three-fifths as heavy as common air. An atmosphere of pure steam would exert a pressure of a little more than nine pounds per square inch; yet the water, from which the steam is generated, is 770 times heavier than air. To the above, from an exchange, it might be added that while air is heavier than steam the liquid from which it is "generated" is about 6 per cent. lighter than water.

A railroad of many tunnels, aggregating one-fifth of the total length of the line, has been opened by the Paris-Lyons-Mediterranean Company from Morez to Sainte-Claude, in the French Alps. The line, in a total length of about 24 km. (15 miles), has eighteen tunnels, representing about 20 per cent. of the entire length, the longest being 1,750 m (more than a mile) long. There are also nine viaducts, the longest having nine spans.

The University of Tennessee has just instituted extension courses in geology especially designed for men engaged in the mining and quarry industries. The courses consist of a short session (six weeks) and correspondence work. The subjects of instruction will be: Physics, chemistry, math-

ematics, geology, mining and metallurgy, and mechanical engineering. The courses are described as especially adapted to meet the need of the man "on the firing line."

One of the highest altitudes recorded by aviators was reached at Hendon, December 16th, when Mr. Sydney Pickles reached a height of 7,200 ft. The Australian airman went up in a Caudron biplane, and was in the air between twenty and twenty-five minutes, when the figure referred to was indicated on his barograph.

The new funicular railway from Lucerne to Dietschiberg, known as the Little Righi, has been opened to traffic. The line is 1,400 yds long, and the cost of construction was about \$70,000. It will be one of the most popular ascents in Switzerland, as the view from the summit, over 2,000 ft. above sea level, is magnificent, including many famous peaks of the Bernese-Oberland.

The recent successful application of a propeller working in the air as a means of propulsion both for a road vehicle and for a canal barge has been followed by some interesting experiments by French officers in Algiers with a kind of sledge mounted on six wheels, driven by a 50-horsepower motor, and similarly equipped with a propeller. This vehicle, which carries three persons, travels easily over the rolling sand at a speed of 12 to 18 miles an hour, and is said to be able to climb gradients of one in five.

The Cumbler Estate has installed a large new steam drill at their limestone quarries near Steelton, Pa. This will be used in drilling holes six inches in diameter through the limestone rock to a depth varying from 75 to 125 feet. These holes will then be charged with an improved blasting powder, and a battery of such holes will be fired simultaneously. Each blast of this kind removes from the face of the limestone cliff a mass of rock estimated to weigh from 40,000 to 60,000 tons. Owing to the scarcity of laborers at the quarries a large steam shovel has been installed to facilitate the loading of the blasted stones on railroad cars.

Think of a boiler shop of the present day without anything pneumatic. Consular Reports in an account of the state railways of the Dutch East Indies and of their several shops gives among other things the equipment of the boiler shop at Bandeong. They have the usual modern machine tools: electric traveling crane, plate planer, plate straightener, bending rolls, shear, drills, punches, but "Compressed air is not used in any part of the works, the management having found that the Javanese workmen are not strong enough to use air hammers properly. Consequently all riveting, caulking, and chipping is done by hand."

At the mines in the vicinity of Battle Mountain, Nevada, the scarcity of water has made it necessary to use it as sparingly as possible. The water is made to circulate through the jackets of the gas-engine and compressor naturally, thus eliminating the trouble and expense of pumps. A large water tank is placed beside the engine and beside the compressor. The water enters the cooling jackets at the bottom. It quickly becomes heated, and as it consequently becomes lighter it rises from the jacket up through the discharge pipe and enters the water tank near the top, the water-level being always kept above the discharge.

The Rio de Janeiro Tramway, Light & Power Co. has a monopoly for supplying the city of Rio de Janeiro with light and power, the power being derived from the falls of Rebeirao das Lages, about 50 miles from Rio de Janeiro, where there is now a plant generating 50,000 horsepower, and 30,000 more horsepower is being added to this station. The reservoir at Lages impounds 204,000,000 cubic meters of water, and in order to keep the level of the water in the reservoir as near constant as possible the company is constructing a tunnel 9 kilometers (5.59 miles) long from the Pirahy river to the reservoir at a great cost. The tunnel will be completed in July, 1913.

An underground river was pierced, on December 23, by the advance heading of the tunnel which is being driven through the Cote d'Or Mountains, in France. The stream of water pierced by the advance heading was of such volume and pressure that

the workmen in the tunnel barely escaped with their lives. Cable dispatches from Berne, on December 28, stated that the flow from the tunnel had increased in volume since it was first pierced and had swelled the rivers in the vicinity to a dangerous extent.

As many as 72 war aeroplanes lined up in a recent review of the French air fleet. Every machine was ready to take to the air, the commanders, pilots and observers standing at attention in front of the machines during the inspection. After a brief and businesslike review by the war minister, machine after machine rose and flew away, 20 of them leaving for posts on the eastern frontier.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

DECEMBER 3.

- 1,045,853. SINTERING-FURNACE. MILTON HENRY KAUFFMAN, Denver, Colo.
 1,045,918. PNEUMATIC FRICTION-CLUTCH. JAMES A. VIELE, Warren, Pa.
 1,045,931. VACUUM-CLEANER. EDWARD M. BARNES, Hastings, Mich.
 1,046,090-1. PNEUMATIC SPRING FOR VEHICLES. RICHARD LIEBAU, Watervliet, N. Y.
 1,046,145. PNEUMATIC LIFTING-JACK. WILLIAM BUDSHEIM, Brooklyn, Md.
 1,046,164. BLOWER-OPERATED WHISTLE. PETER J. FANNING, Providence, R. I.
 1,046,303-4. MEANS FOR REMOVING AIR AND NON-CONDENSED STEAM FROM VACUUM APPARATUS, CONDENSERS, AND THE LIKE. EMIL JOSSE and WILHELM GENSECKE, Charlottenburg, Germany.
 1,046,308. METHOD OF AND MEANS FOR GENERATING POWER. JOSEPH MOSES WARD KITCHEN, East Orange, N. J.
 1. In a steam generating plant, the combination with a boiler of, (1) means comprising a gas generator and an air compressor for generating a combustible gas under a controlled forced air pressure, (2) means for and a place for admixing air for combustion with the combustible gas, said place being located apart from where the gas is generated, and (3) means for securing the burning of the admixed gas and air at the place where the gas and air are admixed, said burning being performed under a controlled forced pressure and under a controlled back pressure.
 1,046,311. HYDROPNEUMATIC DRILL. COLUMBUS K. LASSITER and FRANK E. BOCORSELSKI, Richmond, Va.
 3,492. VALVE SYSTEM AND TRACKER-BOARD. HARRY PIERCE, Kansas City, Mo.

DECEMBER 10.

- 1,046,585. FLUID-ACTUATED CLUTCH. THEODORE A. HAAKONSON, Jelly, Cal.
 1,046,522. METHOD OF BLOWING SOOT. THOMAS E. WHITE, Philadelphia, Pa.

1. The method of cleaning soot from boiler surfaces which comprises carrying heating gases over the surface to be cleaned and simultaneously discharging a fluid over a portion of said surface in opposition to a section of said gases without opposing a remaining section thereof, so that the dislodged soot shall be carried into the unobstructed section of said gases.

- 1,046,603. INJECTOR VACUUM-PRODUCER. FRANK KENNEY, Troutdale, Oreg.
 1,046,610. ORGAN-PIPE ATTACHMENT FOR PNEUMATIC PIANOS. WILLIAM ARNETT KUPP, St. Johnsville, N. Y.
 1,046,706. WINDMILL. JESSE F. YOUNG, Northport, Neb.

- 1,046,716. PROCESS OF COLORING PINEAPPLES. LEWIS E. ARNOLD, Honolulu, Hawaii.

A process for coloring light colored pineapple which comprises sealing the peeled pineapple in a suitable container, evacuating the container to withdraw the air or gases from all the pores or cells of the fruit and admitting to the evacuated container a syrup of refined cane sugar and water which enters all the pores or cells of the pineapple and so affects its properties as to immediately change the color of the pineapple.

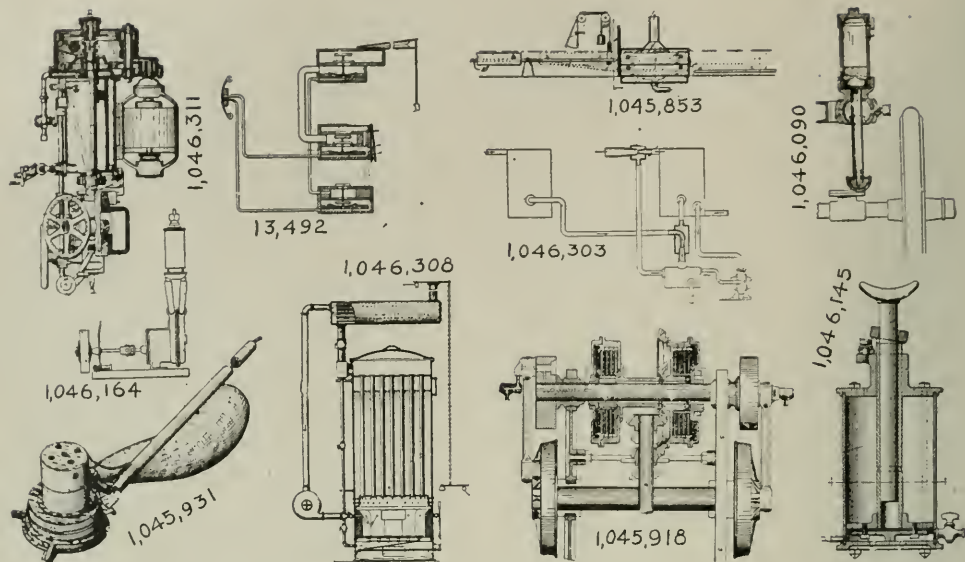
- 1,046,767. DESICCATING APPARATUS. JOHANN MICHAEL GABLER-SALITER, Obergunzburg, Germany.
 1,046,861. FEEDING DEVICE FOR PNEUMATIC TOOLS. BURTON C. SANDERSON, HARVEY D. PALMER and ALLEN R. HODGES, Topeka, Kan.
 1,046,884. MEANS FOR CLEARING THE PIPES OF PNEUMATIC SYSTEMS. IRA H. SPENCER, Hartford, Conn.
 1,047,127. OIL-BURNER. ERASTUS A. HODGE, Spokane, Wash.

DECEMBER 17.

- 1,047,250. BURNER. JOSEPH LEO LANDRY, Napoleonville, La.
 1,047,268. CUSHION-WHEEL. JOHN MILLAR, Arlington, N. J.
 1,047,352. AUTOMATIC AIR-HOSE COUPLING. WILLIAM A. WEIL, Findlay, Ohio.
 1,047,370. PROCESS OF DISINTEGRATING MOLTEN SLAG. JOHN G. BERGQUIST, Chicago, Ill.
 1,047,409. PNEUMATIC-TIRE PUMP-COUP-LING. REGINALD F. HERSEY, Beverly, Mass.
 1,047,487. PNEUMATIC CLEANER. EDWARD M. BARNES, Cleveland, Ohio.
 1,047,489. HYDRAULIC APPARATUS. HENRI BEAU, Paris, France.

A hydraulic apparatus comprising a vertical pipe adapted to contain a column of liquid; upper and lower chambers formed at the lower end of the pipe and forming a continuation thereof; gratings in the sides of the lower chamber; yieldable membranes covering the outer face of said gratings; pockets covering said membranes; an air reservoir communicating with said pockets; means for forcing downwardly said column of water against the pressure of the membranes and the air of the air reservoir, whereby the column is caused to rebound; a check valve at the upper part of the pipe for permitting the efflux of the water when the column rebounds; and means for holding the check valve closed when the column is being forced downwardly.

- 1,047,495. PNEUMATIC WHEEL. ARTHUR BURFOOT and JASPER BURFOOT, Auckland, New Zealand.
 1,047,532. PNEUMATIC HAMMER. WILLIAM S. JOHNSON, Berwick, Pa.
 1,047,547. PNEUMATIC CARRIER. REINHOLD MEIER, Chicago, Ill.
 1,047,585. VACUUM-PUMP. GRAY STAUNTON, Evanston, Ill.
 1,047,590. AIR-ADMISSION DEVICE FOR LOCOMOTIVE FIRE-BOXES. JOHN G. TALMAGE, Cleveland, Ohio.
 1,047,620-1. PNEUMATIC WHEEL. JAMES M. DENNIS and RUSSEL R. DENNIS, Cambridge City, Ind.



PNEUMATIC PATENTS, DECEMBER 3.

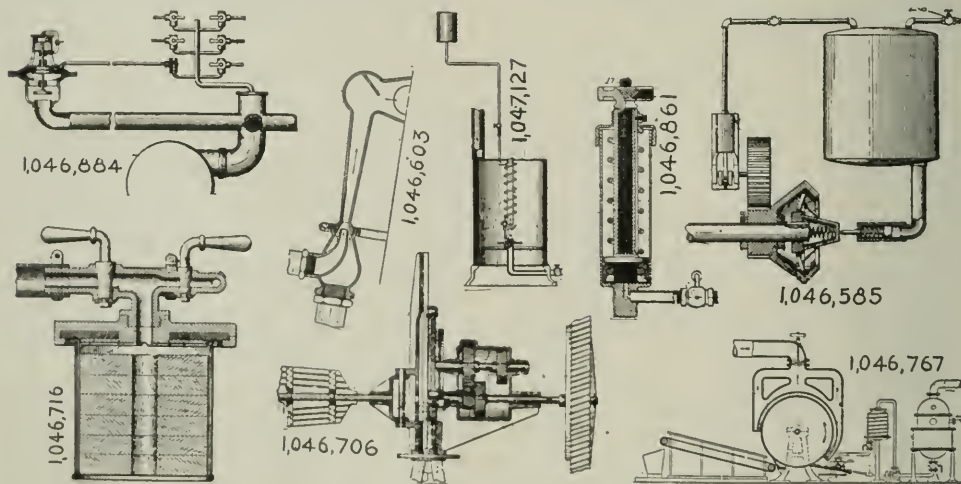
- 1,047,636. CEMENT-MIXER. FRANK C. HORN, Boise, Idaho.
- 1,047,663. TURBINE COMPRESSOR OR PUMP FOR ELASTIC FLUIDS. FRANZ LAWACZEK, Aerzen, near Hameln, Germany.
- 1,047,706. FLUID-ACTUATED GONG. GEORGE R. W. ROBERTS and HARRY HOOPES SEELY, Alameda, Cal.
- 1,047,726. PIPE-CLEANER. ANTHONY J. YOGGERST and LAWRENCE G. YOGGERST, Springfield, Ill.
- 1,047,765. AIR PURIFYING AND HUMIDIFYING APPARATUS. GEORGE C. DERBY, San Francisco, Cal.
- 1,047,826. PROCESS OF OXIDIZING FERROUS TO FERRIC SOLUTIONS. ALEXANDER McKECHNIE, Birmingham, and FREDERIC GEORGE BEASLEY, Smethwick, Birmingham, England.

A process for the manufacture of ferric solution by the direct oxidation of ferrous solutions, consisting in treating such ferrous solutions, in a closed vessel, with air which is blown or forced into the said vessel to maintain therein a pressure exceeding atmospheric pressure while the solutions are also heated above their boiling point, substantially as described.

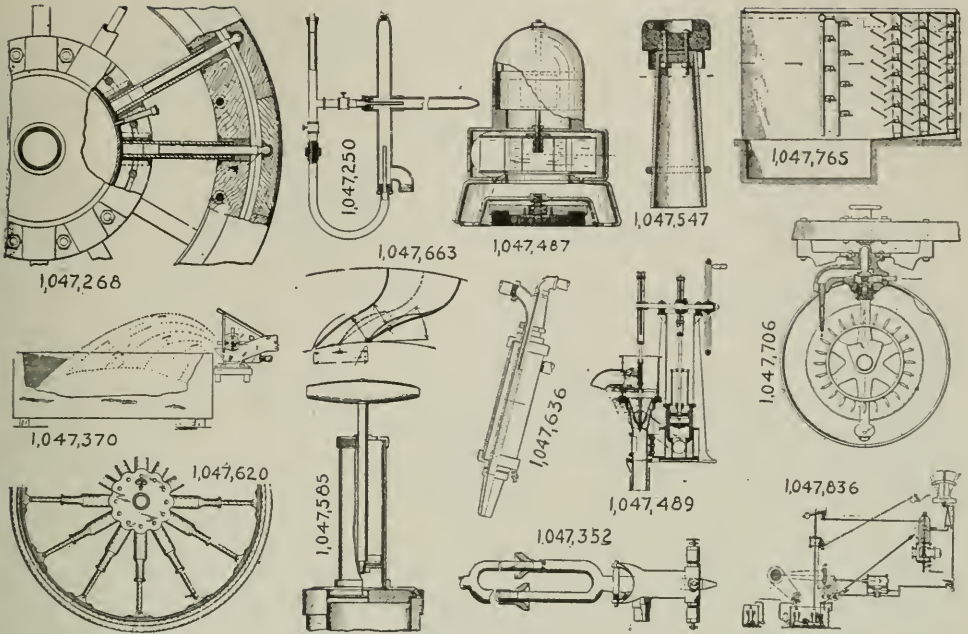
1,047,836. CONTROLLING-GEAR FOR STEAM OR OTHER FLUID ENGINES. HENRY PILING, Lancaster, England.

DECEMBER 24.

- 1,047,911. METER FOR STEAM, AIR, OR OTHER GASES. GEORGE HALE BARRUS, Brookline, Mass.
- 1,047,959. BLOWER-UNLOADING DEVICE. JAMES G. MACLAREN, Weehawken, N. J.



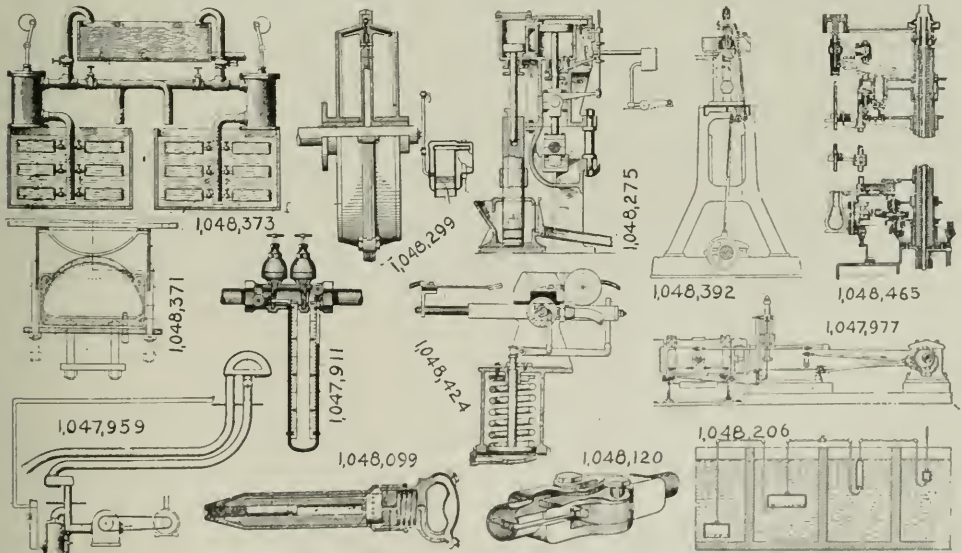
PNEUMATIC PATENTS, DECEMBER 10.



PNEUMATIC PATENTS, DECEMBER 17.

- 1,047,977. VARIABLE-CAPACITY COMPRESSOR. BRUNO V. NORDBERG, Milwaukee, Wis.
 1,048,009. VACUUM-CLEANER. JOHN VOGELZANGS and FRANK E. MORGAN, Green Bay, Wis.
 1,048,099. PNEUMATIC HAMMER. GEORGE L. ROBERTSON, Philadelphia, Pa.
 1,048,120. AUTOMATIC AIR-COUPLING. JAMES C. WRIGHT, Kansas City, Mo.
 1,048,206. AIR-FLUSHING APPARATUS. ALBERT PRIESTMAN, Philadelphia, Pa.

1. In apparatus for the purpose described, the combination of an air-pipe having a liquid-seal, a hydrostatically controlled air-bell communicating with said air-pipe, a sealed pressure accumulator of larger size than said hydrostatically controlled air-bell inclosing the liquid seal of said air-pipe, an air-pipe leading from said accumulator and having a liquid seal, a sealed receiver inclosing the liquid seal of the air-pipe leading from said accumulator, and a delivery



PNEUMATIC PATENTS, DECEMBER 24.

pipe for the flushed air leading from the receiver.

1,048,275. PNEUMATIC PERCUSSIVE MACHINE. HANS CHARLES BEHR, Johannesburg, Transvaal.

1,048,299. PNEUMATIC CLUTCH, JAMES T. DICKSON, Los Angeles, Cal.

1,048,301. PNEUMATIC JACK. LOUIS J. DITTMAR, Louisville, Ky.

1,048,371. PNEUMATIC CUSHION-SPRING FOR WHEELED VEHICLES. JOSEPH WILLIAM SUTTON, Brisbane, Queensland, Australia.

1,048,373. APPARATUS FOR PRECIPITATING VALUE-BEARING SOLUTIONS. WHITMAN SYMMES, Virginia City, and WALTER E. TRENT, Reno, Nev.

1. An apparatus for the precipitation of cyanid solution for the recovery of metal values therefrom, the same comprising a receiving vessel for the solution, a suction pipe extended

MACHINES. CLARENCE M. HENDERSON, Berkeley, Cal.

1,048,737. VACUUM-PUMP AND AIR-COMPRESSOR. ROBERT A. SALLEE, Middletown, Cal.

1,048,812. PROCESS OF MANUFACTURING OXYGEN. HENRY L. DOHERTY, New York, N. Y.

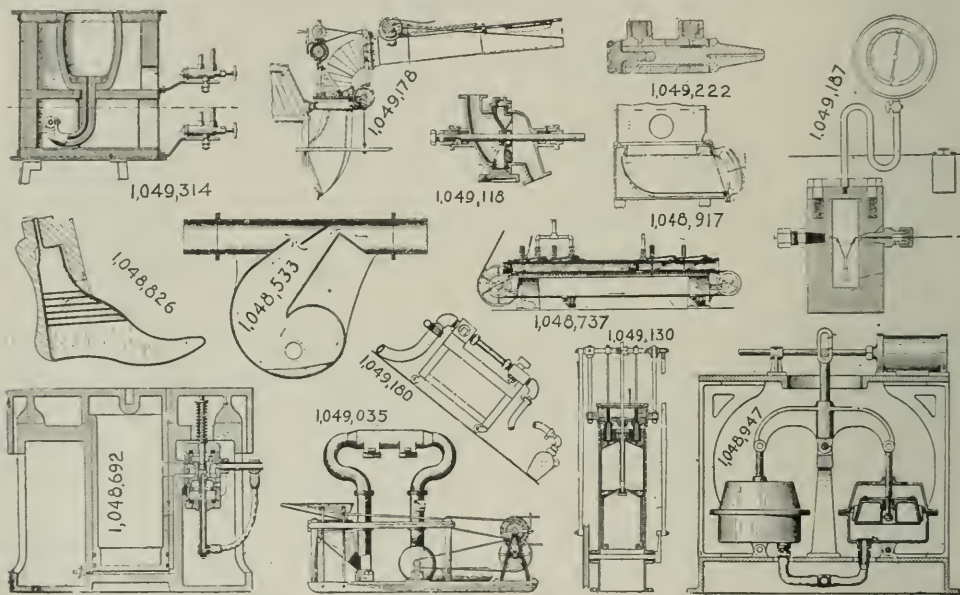
1. In the manufacture of oxygen from a peroxid the method of heating the peroxid which comprises re-heating a portion of the oxygen evolved from the said peroxid and contacting the said re-heated oxygen with the said peroxid.

1,048,826. PNEUMATIC BOOT-TREE. AUGUST HERMANN MAX GRUNE, Pirmasens, Germany.

1,048,931. PNEUMATIC-DESPATCH APPARATUS. THOMAS BEMIS, Indianapolis, Ind.

1,048,917. VACUUM CLEANING SYSTEM. FRANK W. VAN NESS, Milwaukee, Wis.

1,048,947. PUMP FOR VACUUM SYSTEMS,



PNEUMATIC PATENTS, DECEMBER 31.

therefrom, a vacuum pan or tray containing a filtering medium and a fixed bed of precipitant arranged in advance of the filtering medium, connection between the vacuum pan and the suction pipe, and means connected to the suction pipe for drawing the solution from the receiving vessel through the fixed bed of precipitant within the vacuum pan.

1,048,392. AMMONIA-COMPRESSOR AND VALVE-OPERATING MECHANISM THEREFOR. JAMES H. DENNEY, Detroit, Mich.

1,048,424. FLUID-PRESSURE GOVERNOR. JOSEPH F. MENNINGEN, West Allis, Wis.

1,048,465. GLASS-BLOWING MACHINE. CORNELIUS J. NOLAN, Toledo, Ohio.

DECEMBER 31.

1,048,486. PNEUMATIC PIANO. WILLIAM G. BETZ, Chicago Heights, Ill.

1,048,507. AUTOMATIC ELECTRIC AIR-BRAKE. EDWARD H. DEWSON, New York, N. Y., and WALTER V. TURNER, Edgewood, Pa.

1,048,533. GAS-SEPARATOR. LOUIS A. HOFFMAN, JR., Leetonia, Ohio.

1,048,615. VALVE FOR PNEUMATIC PIANO-PLAYERS, ETC. JOHN A. WESER, New York, N. Y.

1,048,692. VALVE FOR IMPACT MOLDING-

HARRY B. CORNISH, Minneapolis, Minn.

1,049,035. CONCENTRATOR. FREDERICK M. ATKINSON, Chicago, Ill.

1,049,118. CENTRIFUGAL AIR-PUMP. GEORGES MASSIP, Paris, France.

1,049,130. VACUUM-PUMP. ALEKSANDER MORAWSKI, Warsaw, Russia.

1,049,178. PNEUMATIC STACKER. EDWARD J. VRAALSTAD, Buffalo, N. Y.

1,049,180. APPARATUS FOR HANDLING GRAPE-JUICE AND OTHER FLUIDS. FRANK J. WALKER, JR., Erie, Pa.

2. In an apparatus of the character described, a fluid receiving tank, means to exhaust air therefrom, an automatic valve therein adapted to be operated by the fluid level in said tank to stop the flow of air from said tank, a fluid supply pipe leading into said tank, and a valve in said supply-pipe, substantially as set forth.

1,049,187. PRESSURE-INDICATOR. JAMES H. WILSON, Ashland, Pa.

1,049,222. ACETYLENE-OXYGEN WELDING-TORCH. JOHN D. FREAR, Centerville, Kan.

1,049,306. SAFETY AIR-BRAKE VALVE. FRANK T. JONES, Baltimore, Md.

1,049,314. APPARATUS FOR ATOMIZING METALS. JAMES MILLAR NEIL, New York, N. Y.

COMPRESSED AIR

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No. 3



FIG. 2. SITE OF KENSICO DAM.

ROCK DRILLING AT THE KENSICO DAM

BY FRANK RICHARDS.

Great engineering undertakings, such as the building of the dam at Valhalla, N. Y., for the immense Kensico storage reservoir of the New York City water service, are now so familiar as to call for little description or remark in the current technical press, except for the fact that

most of these works have each some special feature of interest different from any other, and carrying some new lesson to the profession as to means and methods employed; and, as will appear, this is particularly true in the present instance.

Fig. 1 is a snapshot of the front of the dam of the old Kensico reservoir, which belonged to the original Croton system, the spillway,

which was the only rock-faced portion of the dam, having been cut away, its outline appearing at the left of the opening. This view was taken at an early stage of the present work.

The contractor for the new dam is H. S. Kerbaugh, Incorporated; Mr. B. R. Value is chief engineer, and Mr. B. C. Collier is assistant engineer. The contractors have been in charge since September, 1910, and they have installed a plant costing about a million dollars.

The general line of the dam is northwest and southeast. The structure will be 1,843 ft. long, about 300 ft. in maximum height, and

k. v. a. transformers which reduce the potential to 2,200 volts, which is used on the distribution lines. Pole-type transformers of either 488 or 244 volts are employed to furnish current to the machines.

The dam site is spanned by two 10-ton movable cableways, each of 1,860 ft. span, which have been installed not for the excavation but mainly to handle the new material of construction. The lower part of the dam will be built by travelers, four of these in a group facing each other across the 79-ft. space between adjacent expansion joints. The tracks for the travelers and for the cars bringing materials to the dam will be carried on con-



FIG. 1. OLD KENSICO DAM.

for 1000 ft. of its length it will be 170 ft. high. Just under the coping it will be 28 ft. thick. It will contain more than 1,000,000 cu. yds. of cyclopean concrete, and will have an upstream face of concrete blocks. The artificial lake which will be formed when the reservoir is full will be 30 miles around and the water stored will be equal to the total consumption of New York for some months.

Electric power is employed for all the apparatus except the steam shovels. The transmission line for the three phase, 60-cycle, alternating current follows the aqueduct right of way from Yonkers to a substation near one end of the dam site. Here there are six 667-

crete piers. Each traveler will have two derricks, which will each be equipped with 75 h. p. Maine electric hoists geared to handle 16 tons at 45 ft. per min. or 6 tons at 115 ft.

Fig. 2 is a general view of the dam site in the earlier stages of the work with not more than one-half of the excavation accomplished, and that at the southeastern end of the site, behind the spectator, scarcely begun. The farther bank, as will be seen, has been cut into at the top to give the dam a secure abutment at that end, and the excavation has proceeded from there downward and along the base of the dam. The work of erecting the dam can begin at the one end before the completion of



FIG. 3. GROUP OF ELECTRIC AIR DRILLS.

plan adopted here was to drill a great number of vertical holes, all bottoming at a common level, to load these with high explosive and to fire a great number of the holes at once, thus the excavation, and with the work in full swing both operations may proceed simultaneously without interfering with each other.

It will easily appear that the most important and responsible mechanical agency in the execution of the work is undoubtedly the rock drill. Upon it devolves the task not only of cutting away the rock which at present occupies and encumbers the site, but also of cutting out of the solid bed practically all the rock material which is to constitute the new

dam structure. For the work of excavation a number of standard Ingersoll-Rand percussion, air-driven drills have been employed, the air being supplied by two electric driven compressors.

For the more responsible work of supplying the new rock material for the dam a site for a quarry has been selected about half a mile east from the southeast end of the dam, the rock which is clean and flawless being classed as a gneissoid granite. The original surface of this quarry site was covered with second growth timber which was cut off, and when the soil had been removed the glacier-scored surface was exposed as seen in our views. The



FIG. 4. ROCK SURFACE WITH DRILLED HOLES.



FIG. 5. AFTER THE BLAST.

breaking up the material so that it could be easily removed by the steam shovel.

For this drilling Electric-Air drills are employed, the entire contract calling for 30 of these machines. It must strike one that the drilling conditions are quite favorable here, or, it might be said, the rock drillers job would seem to be a comfortable one. The surface affords a good and almost level footing for the tripods, there are no obstructions in moving from hole to hole, and the drills employed have certainly "made good." When the photos were taken each drill was operated by two men putting down two 20 foot holes for the eight hour shift.

The drill and tripod weigh less than air-driven rock drill of equal capacity, and they are easily moved from hole to hole—six feet—while the pulsator apparatus is handled almost as easily as a baby carriage, and it is to be remembered that there is no expense or labor required for laying and extending air pipes. The stringing of the wires along the ground comprises the entire power connection between the drill and the power house. Figs. 3, 4, 5 tell the story of the quarry operation. In Fig. 3 we see a group of electric air drills at work; Fig. 4 shows the quarry surface after the drilling, each hole being made conspicuous by the wooden plug which has

been inserted, and Fig. 5 shows how the rock looked after some 1,200 holes had been fired all at once.

THE DRILL WAGON.

Besides the tripod electric air drills there are also four electric-air "drill wagons" on the job. One of these is shown in Fig. 6. It carries an electric-air drill of larger size, putting down larger and deeper holes. This machine is entirely self-contained, and is moved along upon a temporary track as the work proceeds. The drill has a vertical power feed of 6 feet, traveling up and down the vertical guides at the right, while the lighter and higher frame at the left is for a power hoist for the steels, taking them out of the hole at a single lift, except for the last steel or two when the holes are getting down to the depth limit.

THE DRILL SHARPENER.

Quite a change in drilling practice generally has resulted from the advent of the mechanical drill sharpener. It is no longer the best practice to try to get as much work as possible out of the steels before sending them to the blacksmith for redressing, and there is no longer any thought of saving blacksmith work. The machine does the work so much quicker and so much more effectively and precisely that it

is difficult to make comparisons. A Leyner drill sharpener is maintained in connection with these drills and a mule is constantly employed in "snaking" the steels back and forth. The steels are kept constantly in the most effective working condition, the gage for each steel is maintained precisely and the reduction of bore for the successive steels is minimized where that feature is of any importance.

While the electric-air drills in use here have had the full benefit of the drill sharpener service they are concededly a pronounced success independently of that. They were not adopted at all as an experiment but upon reliable evidence in advance as to what they could do; and they are doing it.

The electric air drill proves itself to be the full equal, and a little more, of any air operated or other drill of the same capacity; that is in drilling holes of the same diameter and depth in rock of the same character. It strikes a sharper blow, its blows are timed to a uniform and constant rapidity, it avoids sticking in the hole, so that in a day, or any other given time of sufficient length, it shows as much accomplished, or a little more than any other type of drill can show, and in comparisons as to actual performance it requires no allowances or concessions of any kind. The cost of maintenance of each drilling outfit—drill and pulsator—is no more than that of the air drill. The simplicity of the drill unit and its little liability to wear or accident balances the repair and maintenance of the pulsator part.

The electric air drill complete costs more than the air driven drill taken alone, but the air drill, with its share of the compressor which drives it, and the piping and appurtenances, costs much more than the electric air drill, and for mere first cost when installing a plant the latter shows a great advantage. The piping and appurtenances alone for the air drill will more than cover the excess of cost of the electric air drill, and then we might say that there is the cost of the big air compressor plant on the one side and that of the electric generator plant upon the other; but in so many cases, like the present, the generating plant costs nothing, because current can be furnished by the big electric companies cheaper than it could be produced by any isolated plant.

POWER COST OF ELECTRIC AIR DRILLING.

But the most interesting and really the most



FIG. 6. ELECTRIC AIR DRILL WAGON.

important question in regard to work of the extensive and protracted character here involved is as to the power consumption and the total cost of operating. Here we have results which can only be characterized as astonishing.

First, as to the drill wagon. The one seen in Fig. 6 has been in service four months. It is drilling holes to a maximum depth of about 30 ft., using a 5 or 5½ in. starter and bottoming at 4 to 4½ in., the average depth of holes for 8 hrs. ranging from 45 to 65 feet. Under test conditions 104 ft. of hole has been drilled per shift.

Any comparison between the performance of this drill and the standard churn or well drill must be based more or less upon assumption, as no well drill has been actually operated in the same rock alongside this apparatus. Competent experts, however, state that the standard well drill could not drill this rock at a rate of more than 10 ft. per shift. Under the best conditions the cost with the well drill

would average between \$0.80 and \$1.00 per foot. The actual cost per foot obtained on the electric pneumatic drill wagon is made up as follows:

Electric Power for 8 hours.....	\$0.60
1 Drill Runner.....	4.00
Helper	2.50

Basing the cost per foot upon the power and labor charges alone and considering the average daily work as 50 ft., which is very conservative, would bring the cost per foot to approximately \$0.14. With a driller representing the builders of the drill this cost was cut in half and it is believed that when the three other machines also are drilling and the usual rivalry develops between the crews the drilling capacity will go up materially, probably from 60 to 75 ft. per shift, and this would bring the cost per foot for power and labor to \$0.10 or less.

The wagon is as readily handled as any of the heavy churn drills, and its cost of maintenance is believed to be no greater, but the extraordinary feature is the power cost. This sometimes runs as low as \$0.30 per day, and is never higher than \$0.75. It is understood that the electric power, 3-phase, 60 cycle, 220 volt, is costing the contractor \$0.0125 (1¼ cents) per K. W. hour.

The power cost of the electric air tripod drills is between 30 and 40 cents per day, drill runner \$3.50 to \$3.75 per day, and helper \$2.50. The holes are 10 to 15 ft. deep, bottoming at 1¾ in., and the average drilling per shift is 35 to 45 ft. This would make the drilling cost of these machines, based on power and labor (power 35 cents per day) approximately 20 cents per foot of hole drilled).

Comparison is suggested between the performance of these electric air tripod drills and that of standard 3½ in. air operated drills. Assuming that the average free air consumption per drill per minute is 150 cu. ft. compressed to 90 or 100 lb. and taking the air from the highest type of Corliss Compound Condensing Engine Driven Compressor, with high pressure boiler, etc., would bring the power cost alone to 75 cents per day. Adding interest charges on the entire compressor installation, cost of appurtenances, pipe lines, etc., maintenance and depreciation would bring this cost of power per drill per day to \$1.25 or \$1.50, or

between three and four times the power cost shown for the electric air drill.

There are also working upon this contract some 3½ in. air driven drills of the type referred to above, which began work before the electric air drills were installed, and it has been found that with both working in the same rock the electric air drills actually average from 5 to 10 ft. per shift more than the air drills.

If instead of assuming the most economical type of compressor for the above comparison, the air had been taken from a straight line compressor of the old and still familiar pattern, working noncondensing with steam below 100 lb., etc., the discrepancy in costs would be much greater. In these installations experience has made it common practice to figure the power cost per drill at \$2.50 to \$3.00 per day.

Summing up in a sentence: it may be stated upon authority that the electric air drill wagon operating under the conditions and in the type of rock as found at Valhalla, is drilling these large blast holes to 30 ft. in depth at about 1-5 to 1-6 of the cost of any other drilling apparatus now known, and the electric-air drills are doing their work at ⅓ to ¼ the cost at which it could be done by any standard air-driven drill with the air supplied by the most economical air compressor.

Such a remarkable showing gives the Ken-sico reservoir contract a special interest to advanced engineers who are studying economical construction.

AIR BLAST IN FOUNDATION SINKING

The Underpinning and Foundation Company, 290 Broadway, New York, are employing a novel mode of constructing building foundations, the latest undertaking being for a 12 story apartment house at 85th Street and West End Avenue. When completed the foundation rests upon rock and may be called a reinforced concrete structure, it consisting of groups of 12 in. steel pipe filled with concrete and vertical steel reinforcing rods.

The ground is here hard and compact with the underlying rock at varying depths from 17 to 52 feet. The pipes used are in lengths of 12 or 14 feet, and in the deepest parts three or four of these are required, one above the other. The pipe after being properly located in a vertical position is driven a few feet by a Goubert pile driver sitting



FIG. 1. GOUBERT HAMMER ON PIPE.

on the top of it. This hammer can be operated by either steam or air, and when in this case it was operated by air means of reheating the air were employed as close as possible to the hammer to prevent the freezing of the exhaust.

The pipe having thus been driven a certain distance, the Goubert hammer is lifted off by a derrick, the pipe is filled with water, an air pipe is thrust down as far as it will go and also a test rod which is used to ascertain when the solid rock is reached.

On the street close to the work is located a 20 in. Rand compressor and a large air receiver. The compressor is speeded up and when the receiver is filled to the highest working pressure all the air is suddenly turned into the foundation pipe blowing out the water, the dirt and the stones. This filling and blowing out is repeated several times until the air pipe has sunk to the bottom of the casing pipe. Then the hammer is put to work again, the pipe is driven another couple of feet or so, then it is filled and blown out again and so on until the rock is reached. The pipe is even finally



FIG. 2. BLOWING OUT.

(Continued on Page 6750.)

A COMPRESSED AIR TRANSMISSION CHART*

BY NATHANIEL HERZ.

The formula frequently used for computing the economical size of pipe to transmit compressed air is that of D'Arcy, as follows:

$$DC = \sqrt{\frac{d^5 (p_1 - p_2)}{w_1 l}}$$

Where,

D = The volume of compressed air delivered in cu.ft. per min., at the final pressure;

c = An experimental coefficient determined for the various sizes of pipe;

d = The diameter of the pipe in inches;

l = The length of the pipe in feet;

p_1 = The initial gage pressure in lb. per sq. in.;

p_2 = The final gage pressure in lb. per sq. in.;

w_1 = The density of the air, or the weight in lb. per cu.ft. at the initial pressure, p_1 .

The most common case is that in which the given quantities are: the quantity of air required, the length of the pipe, and the initial pressure. The method of solution is to assume a pressure loss and to compute the remaining factor, $c \sqrt{d^5}$, thus giving the size of pipe corresponding to the assumed loss of pressure. It is always desirable to try two or more pressure drops, in order to find the combination that is most satisfactory, since often a small change in the size of pipe will reduce or increase the loss of pressure several pounds. An alternative method is to assume a size of pipe and calculate the corresponding pressure drop. Each method involves a series of tedious calculations to arrive at the most economical solution, and also requires the use of tables giving the constant, c , the actual diameters corresponding to the nominal pipe sizes, the density of the air, w_1 , and often, for convenience, a table giving the value of the expression.

A graphic chart (see opposite page) has been

$$\sqrt{\frac{p_1 - p_2}{w_1}}$$

constructed for the solution of these problems with no computation, and without the use of tables. The procedure is as follows:

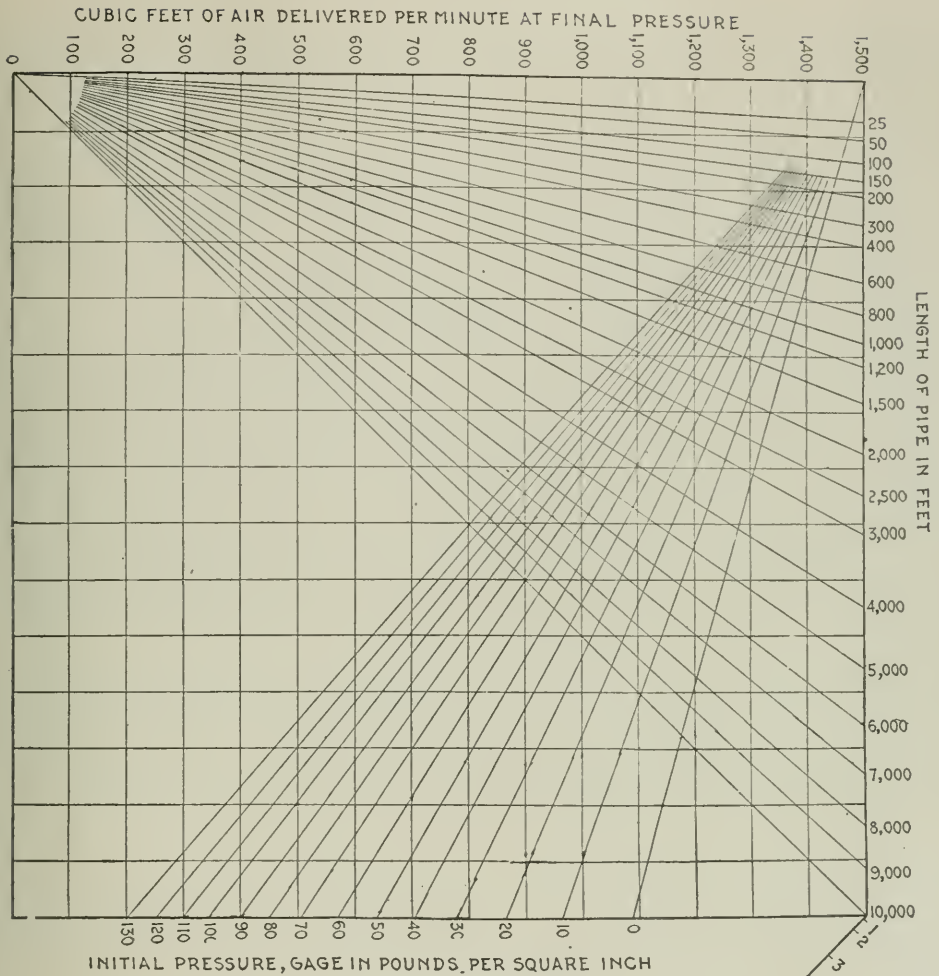
Begin with the quantity of compressed air delivered, on the left-hand vertical scale; follow across horizontally to the intersection with the inclined line corresponding to the length of the pipe line; pass up vertically to the inclined line corresponding to the initial pressure; then cross the chart horizontally to the heavy line at the right of the cross-sectioned part of the chart. The point here found is a pivot point, which is held with a pencil, pen, or needle point, and a straight-edge placed against it and swung across the "Z" diagram. Any two points on the inclined and vertical lines that are cut by the straight-edge at the same time go together as one solution of the problem, giving a pipe diameter with its corresponding loss of pressure. By swinging the straight-edge, it is possible to see at a glance how the final pressure is affected by a variation of 1 in. in the pipe size. Moreover, the size giving the most desirable result is determined at one operation. If the drop is considerable, it may be desirable to adjust the volume to correspond with the new final pressure, and to repeat the operation; but, within ordinary economical limits, the error involved by not doing so is negligible.

Sometimes the problem may arise in another form; for instance, to find the maximum volume that can be handled in an existing line. In this case, the process is reversed. Begin with the maximum desirable drop, and the size of pipe, then pass to the initial-pressure line in a horizontal direction, then vertically to the length line, and finally horizontal to the left-hand scale, which will give the corresponding volume. Any other combination can be solved in a similar manner.

The accuracy of this chart is well within commercial limits. It has been checked against calculated values for combinations varying from 100 to 1000 cu.ft. of compressed air delivered per minute, pressure losses from three to 10 lb., and pipes from 10 to 4000 ft. long; all results were within 0.5 in. of the pipe diameter, and most of them within 0.25 in. or less.

Nearly 50 tons of water had to be raised out of the mines of South Staffordshire, Eng., last year to every ton of mineral.

*Excerpt from Bulletin A. I. M. E., Dec., 1912.



A GRAPHIC SOLUTION OF
D'ARCY'S FORMULA
FOR THE TRANSMISSION OF
COMPRESSED AIR IN PIPES

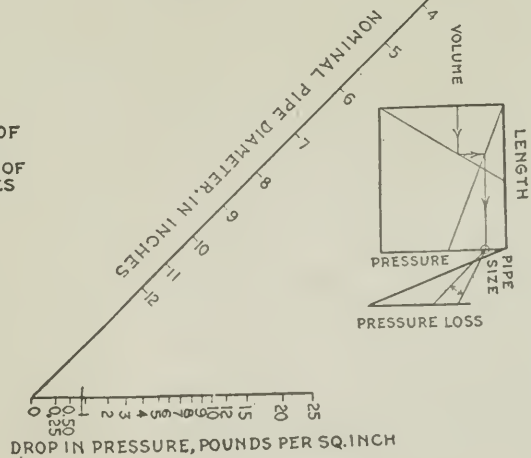




FIG. 1. ONE OF THE TUNNEL-BRIDGES.

REINFORCING TUNNEL LININGS

BY FRANK RICHARDS.

An unusual and difficult engineering task has recently been accomplished at the Bergen Hill, Jersey City cut, of the Erie Railroad. This is a deep open cut with four tracks now used for the passenger traffic of the road, instead of the long and smoky tunnel so unpleasantly remembered by old travelers.

This cut is crossed by four tunnel-bridges at important boulevard crossings. One of these is shown in Fig. 1 with the light from the other side showing upon the tracks below. These tunnels have thick concrete roofs or linings which have developed serious leaks and disintegrating tendencies that have begun to urgently demand remedial measures. It was apparent that no doctoring of the concrete from within the tunnel could be permanently effective, and it was determined to drill down to the concrete from the street surface above and to pour in sufficient grouting to solidify the entire mass. As there is more or less timbering above the concrete there are cavities sufficient to provide free flow for the grouting.

The most difficult part of the undertaking was the drilling of the holes, and at this writ-

ing this has been successfully accomplished. The depths to be drilled varied from less than 40 to more than 50 feet, which would not have been a serious matter if it were all in solid rock. Upon the average about one-half of the drilling was through a heterogenous mass of material comprising earth, stones, more or less iron and other rubbish compacted together, with occasionally loose or unfilled spaces, so that the drill runner was in constant anxiety and alertness to prevent the drill piston striking the front head.

This evidently was not a case where a tripod drill could be used to advantage, and the drill actually employed was a G-105, Ingersoll-Rand drill with steam cylinder $4\frac{1}{4}$ in. diameter and 8 in. stroke. This drill was mounted upon a drill wagon (Fig. 2) which provides a secure guide for the drill and carries also a 15 H. P. boiler to supply the steam. The guide for the drill provides a feed of $4\frac{1}{2}$ feet and its base is a quadrant pivoted at the rear and permitting a horizontal movement of 30 degrees or more by which the drill may be moved laterally to either side when steels are to be changed, and immediately returned to correct alignment for drilling. A small auxiliary engine operates the feed screw for hoisting the drill or for running it up or



FIG. 2. DRILL WAGON AND GANG.

down as required, the feed when actually drilling being generally by hand. The derrick provides a central hoist of 20 ft. for the steels.

Each hole was started with a $4\frac{7}{8}$ in. bit, and as each limit of feed was reached a 4 ft. length of 4 in. casing was inserted. The casing was driven down by the steam piston striking upon a block. The chief purpose of the casing, which was continued only until solid rock was reached, was to prevent the dropping of loose material to choke the drill and also to keep the hole straight. Even this precaution was not always effective. The writer watched the drilling of the last foot of solid rock reached by a 20 ft. length of steel, and when it came to lifting out the steel this actually took a longer time than the drilling, the drill being caught by some obstruction after pulling up a short distance.

It took about three days to drill the first hole, great care being required to avoid striking the cement-casing which was 5 ft. thick.

In the later holes it became easier to determine when the lining was nearly reached. On the second hole they had a harder time, several steels being broken before the depth was reached. With the 30 ft. steel in use the boiler was taxed to its limit for steam. The steel shown in Fig. 3 only just reached the bottom of the deepest holes.

No complete statement can be given of the quantity of cement used. When the work was visited 1,600 bags mixed very thin had been poured into the first hole, and the indications were that 1,000 more bags would be required. From the condition of the casing to be reinforced, the pouring in of the grout from above entailed a great amount of alertness and ingenuity in the tunnel to stop the leaks and hold the material from escaping. For this work platforms were provided upon flat cars and a lot of men had to work like beavers with oakum and other materials for stopping the flow, and even then everything was covered



FIG. 3. ONE OF THE STEELS.

with leakage, making an interesting study in monochrome.

The work is being carried on by the Smith & McCormick Company.

COMPRESSED AIR AIDS QUARRY ELECTRIFICATION

BY CHAS. A. HIRSCHBERG.

That electricity in the quarry has merit not possessed by any other power transmitter cannot be gainsaid. Especially does this hold true in the colder climates, in such quarries where winter operations are not only desirable but necessary to meet the increasingly large demand for dimension stone and crushed rock products.

To give the unfamiliar reader a better understanding of the conditions obtaining in quarries operating in winter, a brief outline is here given of the various kinds of quarrying machinery in use, the class of work to which each is adapted, and the advantages and disadvantages peculiar to each.

Broadly speaking, there are two main classes of quarrying machinery, namely: the track channeler and the rock drill for quarry bar, tripod, gadder and hand use.

The track channeler may be of several types; fixed back or adjustable back or arranged for undercutting.

The first is adapted for service in those quarries where the rock beds are horizontal or nearly so; the second, for angular cuttings in quarries where the floor is to be enlarged or where the formation dips or inclines and it is desirable to follow it without removing the overlying rock. This latter type is more frequently employed in quarrying marble. The track channeler is used in making the long deep longitudinal cuts (averaging from 8 to 16 feet in depth, depending upon the nature of the stone) which are preliminary to further breaking by the plug and feather method. The undercutting channeler is intended to meet conditions in quarries of marble, slate, sandstone and other rocks, in which there are no free horizontal beds and where the cleavage of the stone is vertical, or nearly so. In such places, it is necessary to undercut the bench as well as to channel the sides.

The different makes of track channelers on the market, while alike in general principle, differing only in minor details of construction and design as affecting the economy of power consumption, channeling speed and ease of handling may again be divided into three classes; those operated by steam, those in which compressed air is the transmitting power and the electric-air type; which is distinguished by its combined use of electricity and compressed air as a motive power, and

which in this respect is a distinctive departure from all previous practice.

In the second group, that of the rock drill variously mounted, we also have the sub-classification of power; steam, air and electric-air.

This class of machine is used in combination with some type of either special or standard mounting, as for instance the quarry-bar, which is used for channelling purposes and the drilling bits are of regular channelling formation; for broaching, plug and feather work, lofting, etc.

Here, however, we have this distinction, that while the track channeler is operated on a portable track, this outfit consists of a modified drill mounting, with four legs and provided with either two parallel bars in horizontal position as also a horizontal screw feed for moving the drilling engine carriage longitudinally, or a single horizontal bar with a rack feed.

This outfit is moved about from place to place by hand.

These drills are also used in conjunction with the long familiar tripod mounting, and a portable mounting known as a gadder frame for putting in a row of holes in a side wall at any angle from horizontal to vertical. These holes may be either broached or the break may be made by the plug and feather method.

STEAM CHANNELER EQUIPMENT.

Here, it is at once apparent that the chief advantages lie in the securing of greater independence of accessory power plant equipment, this being especially true where the work is of a temporary nature. So far as general efficiency is concerned this type of machine ranks very highly, but the economy of power obtaining with either air or electric current is not to be expected in cold weather owing to radiation and condensation of steam in transmission.

Its disadvantages briefly summed up are, the interference experienced by the operator from exhausting steam, the time consumed attending fires, the discoloration of the stone from coal and ashes and, as above stated, the difficulty experienced from condensed moisture.

COMPRESSED AIR CHANNELER EQUIPMENT.

Here also, we have a very efficient equipment, only applicable, however, under condi-

tions which are ideal. While employing the well known successful application of compressed air, its advantages are more than offset by the many disadvantages to contend with in cold weather operations.

First it is dependent on a central plant, necessitating the laying of pipe lines in the quarry as work progresses, involving considerable labor in addition to the trouble experienced from freezing and bursting pipes, and the necessity for using a reheater attached to the channelling machine. Steam equipment would be far preferable to this.

ELECTRIC-AIR CHANNELER EQUIPMENT.

Here we have a utilization of power with design which makes it an all-around ideal quarry equipment for convenience, economy and adaptability; one that is entirely independent of weather conditions; one that does not necessitate the installation of costly power house equipment by the operator unless he so desires, as current may be cheaply purchased from outside sources. Electric wiring is sub-

This device represents more than an air channeler with a portable electric driven air compressor. It is a complete system in which compressed air produced by a tandem single-acting pulsator driven by a standard electric motor is applied to the piston of the cutting engine, all being mounted on the same frame. The air is never exhausted but plays back and forth under pressure in a closed circuit. There is no rigid connection between the motor pulsator and the cutting engine, this being accomplished by flexible joints.

The same conditions prevailing with channelers are to be met with in the use of all rock quarrying machinery, so that the same substituted for pipe lines, etc.

arguments apply with the second classification.

While Steam and Air equipment have held the bulk of favor during the past years, the tendency toward electrical operation is becoming more and more marked, as its advantages are becoming better known. The ideal will have been attained when the quarry becomes universally electric.

A wooden ship called the Seal, built in 1810 at Southampton, is still in use, and will shortly sail from Biddeford, England, to Durban, South Africa, a distance of 6,000 miles.

THE LEYNER DRILL SHARPENER

The interesting machine here shown would seem to be entitled to a name more suggestive of the scope of its work. It is not only a drill sharpener but it is first of all a drill maker, and it does various other things as the occasion arises. It is an ingenious machine, a highly efficient machine and it challenges interest and appreciation. If we realize the responsibility of the rock drill and the strenuousness of its task in quarrying, mining, tunneling, in all engineering work requiring the rapid piercing of the solid rock, and then how all the success and accomplishment of it de-

blacksmiths have done the best they could, and the drillers have learned to worry along with such bits as they could get, well knowing that they could not dictate much as to the shape or condition of the steels used. The coming of the drill sharpener has reacted upon the driller. He has found that he can get more reliable bits, both as to shape and size, and also temper or stand-up qualities, that he can have them cheaply and quickly renewed, and he never has to strive to get all the work possible out of each steel before changing. The increased day's work tells the story.

The machine is entirely pneumatic in all its

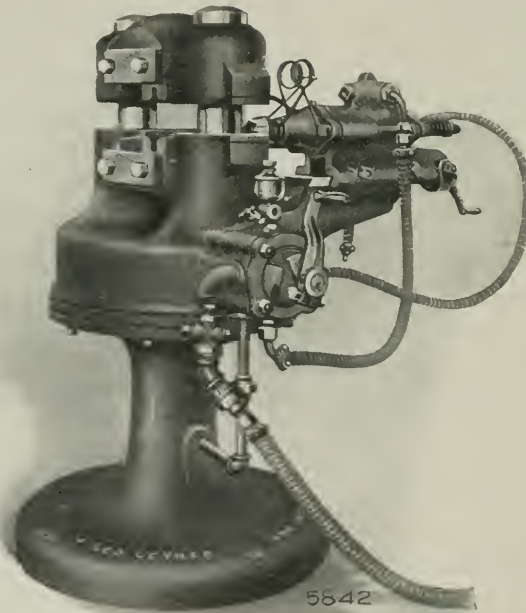


FIG. 1. LEYNER DRILL SHARPENER.

pends upon the proper shaping and maintenance of the drill steels or bits, we may somewhat appreciate the intensified and concentrated responsibility of the agency by which the fitness and efficiency of the drills are to be maintained.

The making and redressing of drill steels is in these days too much of a job for the primitive, unassisted blacksmith and helper, and where more than two or three rock drills are working together hand work is not to be thought of for the drill maintenance. The

functions and is operated by the same air pressure, 70 to 100 lb., which is most satisfactory for the drills. There are three distinct movements or operations. The steel is clamped or held in a horizontal position so securely that no backer is required for the steel in the act of upsetting, and no space is required outside the machine except for the length of the steel itself. In the making or sharpening operation the body of the steel is subjected to no shock or strain, and the normal condition of the metal is not disturbed.

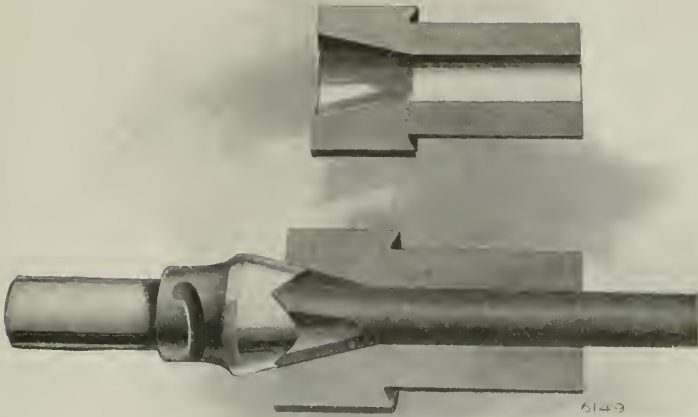


FIG. 2. DIE, DOLLY AND BIT.

The steel with its end heated is brought from the fire and clamped in the vise, which is done by the descent of the heavy crosshead above, this being actuated through the heavy side bolts by the piston in the big, short cylinder below. Dies are inserted in the upper and lower faces of the vise which together form a conical cup or enlargement which limits and shapes the outside of the bit when it is being upset. The dies are quickly removed, replaced or changed as required.

The heated end of the steel projects a little beyond the die as located by a gage and then the dolly is advanced and pressed with great force against the steel, this being the

second movement spoken of, and at once the third movement occurs, this being a sharp and rapid pneumatic hammer action behind the dolly, the combined pressure and hammering very quickly upsetting the steel until it fills the die. For this operation a single heat is sufficient unless the required enlargement is excessive, when two or more heats may be required. The usual end of the operation is when the outside of the dolly fills and fits the conical cavity in the die. As different dollies are required for bits of different sizes, these are not fastened in but held by a light spring so that they can be instantly changed as required.

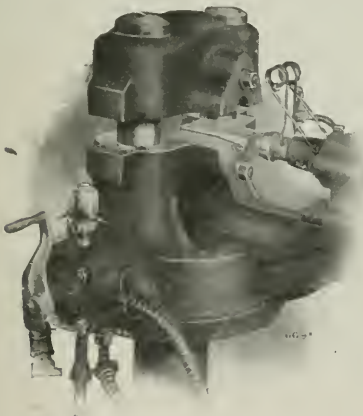


FIG. 3. VICE OPEN TO RECEIVE STEEL.



FIG. 4. STEEL CLAMPED FOR DOLLING.

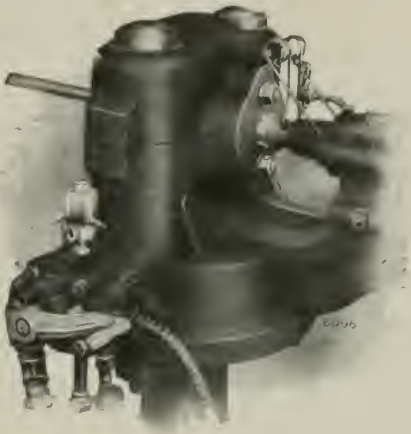


FIG. 5. DOLLYING THE STEEL.

The illustrations should give a tolerably clear idea of the normal operation of the machine. It will be noticed that in Fig. 2 the positions of die, dolly and steel are reversed. The operating of the drill sharpener is a very simple matter, the large crank lever in the front of Fig. 1 controlling all the movements. This lever in the vertical position as shown, raises the crosshead with the top half of the die; moving the lever forward 45 degrees low-

ers the crosshead and clamps the steel, and moving it another 45 degrees operates the dolly. By reversing the movements of the lever the dolly is stopped and the crosshead is raised to its original position.

While the four-point cross bit is more easily made, the single or double chisel, three, four, five or any other number of point bits, as well as the "Z," "X" and other special forms are readily made. The machine is also adopted, by the addition of suitable dies or devices, to many other classes of work. Pipe hangers, pins and spikes, drill steel shanks for either hammer or piston drills, are readily made as well as bolt and rivet heads. Various kinds of bending, forming and forging can be done. Fig. 6 is a view of the back of the vise showing how various swages may be used and how easily they may be inserted or changed by merely slacking the bolts which hold the plates.

HIGH PRESSURE GAS COMING

The Bradford, England, Corporation gas committee has decided to install a system of high-pressure gas lighting for the central portion of the city. It is stated that recently many improvements have been made in the

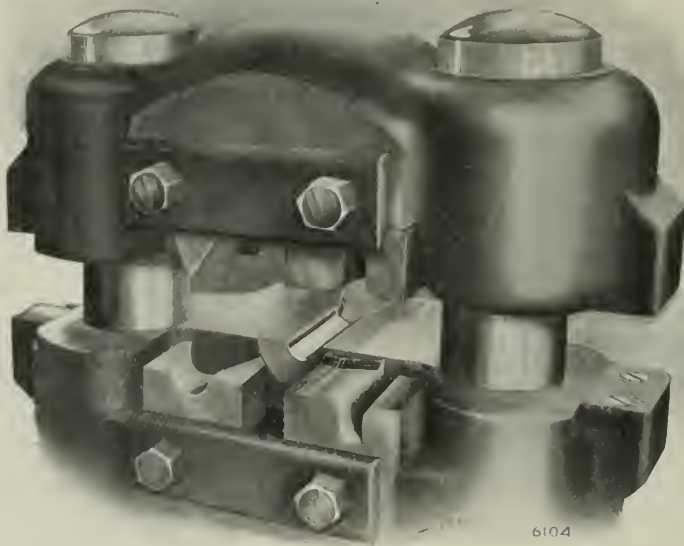
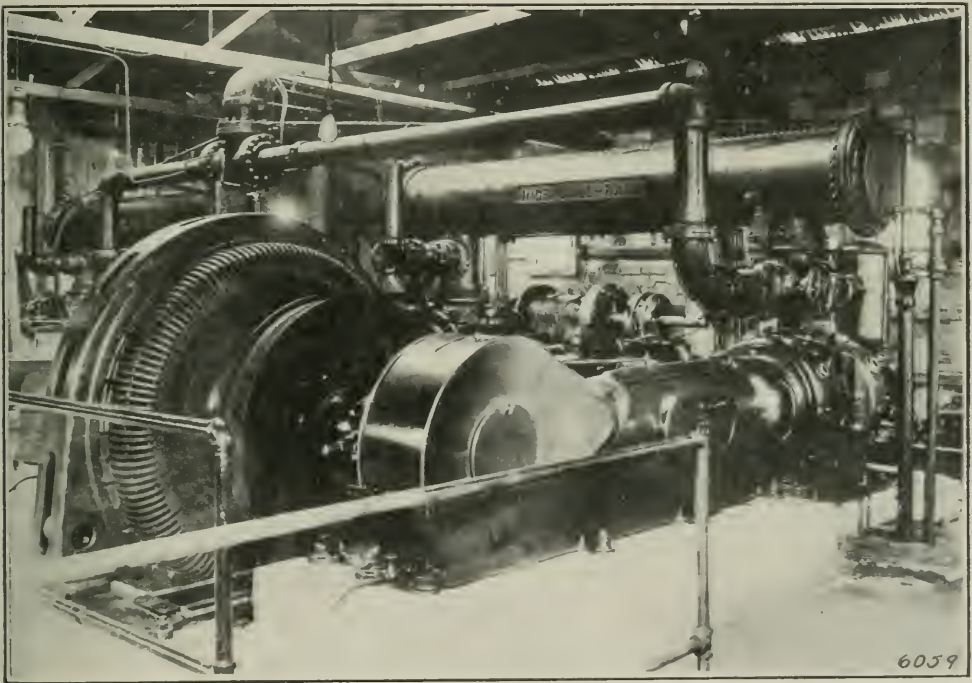


FIG. 6. BACK OF VISE.

apparatus for gas lighting at pressures of from 2 pounds to 3 pounds per square inch and that the system is now in successful operation in several towns. A compressing plant will therefore be installed in Bradford and steel gas mains laid down, at a total cost of \$141,128. With the lamps available it was estimated that three times the amount of light could be obtained from a given consumption of gas under high pressure than from the ordinary incandescent burner, while the extra cost of mantles and maintenance would not be excessive. Some 30 or more firms in Bradford already have their own apparatus for compressing gas for their own use.

tunnels and the subway work, and latest of all the great water tunnel, have not only provided the ways and means for what is best in compressed air practice, but the magnitude of the undertakings has made it worth while, and even imperative, to adopt the most economical and reliable apparatus procurable regardless of the cost of installation.

Accordingly the several air compressing plants employed by the great contracting companies for the works but recently completed were regarded as models of up-to-date-ness in every detail which could promise economy and precision of working, and both the contractors who owned and operated them and the design-



ELECTRIC DRIVEN COMPRESSOR ON SUBWAY CONTRACT.

THE AIR COMPRESSOR AND THE ELECTRIC DRIVE

BY FRANK RICHARDS.

Changes in compressed air practice, or, more precisely, in air compressing practice, have been succeeding each other with astonishing rapidity since the present century began, and nowhere more noticeably than in New York City and its immediate vicinity. Here compressed air has found one of its great opportunities. The North River and the East River

ers and builders who were their sponsors, all were proud of them, and the technical press wrote appreciative descriptions of them as a labor of love.

These were steam driven plants, with all the accepted steam and power economizing devices, which need not here be enumerated in detail, and the air ends also provided for two-stage compression with efficient intercooling and automatic regulation which allowed no power to run to waste when the load was light.

Although the work for which these compressors were employed was necessarily of a temporary character there was no temporizing or makeshift about them, and day by day, comparing their performance with that of "simple" machines which might have done the work, they piled up the savings and paid for themselves over and over.

They made such an excellent showing that, humanly speaking, we might have said that these machines, although their first job was done, would be sure of employment again as soon as there was more work in their line to be done. They were still practically good as new, so there could be no plea of old age suggested against them.

The first batch of New York river tunnels, the first subways, the Pennsylvania terminal, have all been completed. Now we have the great water tunnel being driven the entire length of Manhattan and through Brooklyn to Staten Island, and subways without end are under way, but so far as the present writer is informed not one of these compressors of such excellent record has come into play.

While these fine steam compressors were at work other things also were working. Especially was electricity having a phenomenal business development. Splendidly equipped electric light and power plants of almost unlimited capacity were being installed in New York as well as in every large city, and these taking advantage of every possible economy in steam generating and in power development have been enabled to offer currents for drive have been enabled to offer current for drives at rates which have practically compelled acceptance.

The electric drive under such circumstances is an attractive proposition. The first cost of the electric driven compressor is much less than that of the steam driven plant with boiler, piping and other appurtenances and fuel handling and storing arrangements. The operating force required is reduced to one-fourth or less and the ground occupied is also minimized with no exacting requirements as to location so that generally the compressor may be located much nearer the work with a great saving in air pipe lines. The power required is always ready without preliminary notice and the power cost stops entirely when the compressor stops.

The advantage of the electric drive thus offered has been so evident from a strictly busi-

ness and money making viewpoint that it could not be ignored and new electric driven plants have been installed for the extensive new lines of work because it was simply the cheapest thing to do.

The installation which we get a glimpse of in the halftone herewith is that of the Bradley Contracting Company, New York, which has a contract for a large portion of the Lexington avenue subway. It is located at 96th Street and First Avenue, close to the East River, and it is typical of the plants employed upon this and similar work, there being a score of compressors of the type here shown now in operation in Greater New York.

The plant comprises five Ingersoll-Rand, Class P E-2, electrically driven cross compound compressors with cylinders $25\frac{1}{4}$ in. and $15\frac{1}{4}$ in. diameter and 21 in. stroke, delivering air at 100 lb., gage, with an individual free air capacity, at 187 R. P. M., of 2110 cu. ft. per minute, or an aggregate of 10,550 cu. ft.

These machines have G. E. direct connected self-starting synchromus motors with belted exciters, 365 brake horsepower, 6600 volts, 3 phase, 25 cycle, the rotor mounted on the crank shaft with a bearing in each frame, this arrangement giving a greater efficiency than that of a high-speed belted motor. Current is supplied by the New York Edison Company. The rotor of the motor is heavy enough to give a sufficient flywheel effect, in this assisted also by the pulley which drives the exciter.

A speed of 187 R. P. M.—654 feet piston speed—is high for a compressor of this size, but it is easily practicable with this type of machine by reason of the massive design, the perfectly maintained alignment, the equitable distribution of the load and the flood system of lubrication.

It is not necessary to mention in detail the special features of design and construction in these machines. The frame on each side is of the heavy duty engine type, supported for its entire length upon a massive and carefully prepared foundation, while the cylinders resting on sole-plates are made underneath with full box construction, the box forming a settling chamber for the water jacket.

The cranks, crossheads and connecting rods can all be got at while the machine is running, through the doors on the oil guards and through a larger doorway on the side. A constant flow of oil is delivered to the main bearings, the crank pins and crosshead pins,

and also to crosshead slides and piston rods. The flow of oil begins as the machine starts and its delivery is proportional to the speed, all the oil returning continuously to the oil reservoir. For lubricating the air cylinders, where the desirable quantity is a minimum, sight feed lubricators are provided.

A special conduit running lengthwise under the building is provided for the free air supply. The air inlet valves are of the "Hurricane" piston inlet type and the discharge valves "Cushioned Direct Lift," both having the highest practical endorsement of long and extensive successful service.

A large intercooler is set transversely above the cylinders of each machine, forming the air connection between them. In this case special cooling tubes of "admiralty bronze" are provided, so that the more or less saline water of the East River may be used for the circulation. The tubes are in pairs, an inner and an outer; the cooling water enters the lower row of tubes and passes back and forth between the inner and the outer tubes, discharging from the top row. Leaving the intercooler the water passes around and under the high pressure cylinder and thence to the jacket of the hood, from below, discharging through the side of the cylinder. The air pressure at the intercooler is 27 pounds, gage. After leaving the intercooler and before entering the high pressure cylinder the air passes through a separator which takes care of all the water liberated by the intercooling.

The compressor runs at constant speed, and the means provided for controlling the air output according to the demand is an interesting and important feature. Each end of each cylinder is provided with an auxiliary clearance chamber, and when communication is automatically opened between any clearance chamber and its cylinder the air compressed for that stroke is not discharged into the receiver and pipe system but merely enters the clearance chamber, and upon the return stroke of the piston the force which has been expended in its compression is, upon its reexpansion given back to the piston and little of the power is lost. According to the number of these clearance chambers which may be thrown into action at once, the compressor may be working at full load, three-quarter load, half load, quarter load or no load, and the power consumed will be according to the actual air delivery. In two-

stage machines, such as those of the Bradley Contracting Company are, clearance space in corresponding proportion is used simultaneously on both the low and the high pressure cylinders, thus maintaining the ratio of compression constant and effecting an equal apportionment of the load.

From the preceding it will easily appear that a modern air compressor of the highest type is by no means so simple a machine as some might easily imagine, but all the refinements have full business warrant for their being.

From the compressor house the air is carried by a 10 in. pipe westward to Lexington Avenue, about half a mile, and then it is led away both north and south through long and increasing distances through 6 in. pipes and smaller. From the nature of the work it is impossible to make any intelligible comparison between the power used at the compressor and the power actually realized where the work is going on, as that is so widely distributed, so intermittent and of such varied character. The only thing until the work is finished is to have enough air always ready.

The 10 in. pipe from the compressor house is laid in the gutter in 96th street close to the curb, being carried overhead to cross three avenues. In the middle of each block a sliding expansion joint is placed and the long vertical pipes and curves at crossings also yield more or less. As the air starts on its journey its temperature is not less than 200 degrees, but before Lexington Avenue is reached not the slightest trace of heat remains, which shows how quickly the air cools off and the futility of ever attempting air reheating except close to the work.

Mr. Rea, the new president of the Pennsylvania R. R., was in charge of the building of the new terminal of the Pennsylvania R. R. in New York City. In the course of the work he often donned the oil skins and visited the tunnel being constructed under the East River. Tim McCarthy, foreman of the tunnel gang, became his warm admirer. A few days ago McCarthy heard of Rea's promotion. "Sure, I hope he'll be happy," said he, heartily. "But whin Sammie Rea wint into the railroadin' business there was the makin' of a mighty fine sand hog sp'iled."

AIR BLAST IN FOUNDATION SINKING

(Continued from Page 6736.)

driven about two feet into the rock, the familiar New York mica-schist.

When the driving for the individual pipe is finished several steel rods are inserted and then both the outside and the rods are cut off to the required level by the oxy-acetylene torch, the pipe is filled with concrete and finally capped.

In this particular foundation the engineers have estimated 4,200 lb. per sq. in. as a safe load for the reinforcing rods and the pipe and 350 lb. per sq. in. for the concrete, the piles being distributed according to the requirements of the building and the varying characteristics of the ground.

This method is also being successfully employed for putting in new foundations under old buildings, a section of the building being cut out to give room for a short length of pipe and a hydraulic jack, the pipe being alternately jacked down and blown out and followed by additional lengths of pipe until the required depth is reached.

THE BUTTERFLY PICKAXE

BY S. W. SYMONS.

The versatility of the well known "Butterfly" hammer drill is being thoroughly demonstrated at the New York Terminal of the Brooklyn Bridge, where eleven of them are being used by the North Eastern Construction Co., to cut through cement, concrete, brick, and even steel ties, to make room for the Brooklyn Bridge Terminal of one of the new subways with which New York is being honey-combed and which, like most subways, is crowding its way through without regard for what ancient institutions like the Brooklyn Bridge it may overthrow in its progress. In this case no actual damage will be done, though it is probable that the bridge will be closed for a short period, and when reopened will present a different appearance at the New York terminus.

The "Butterfly" Drills are used to cut through the road-way from the entrance and 3rd Ave. street car tracks to the anchorage, the work at present being in progress only where there is no traffic.

The drills have to be relied upon to do everything, as blasting in this confined and congested place is prohibited. They are in



FIG. 1.

fact called upon to perform the same class of work as in the old days would have been done with the common pick-axe, and in this case they might well be termed "Compressed Air Pickaxes." The roadway to be removed is of very substantial construction: first there is a layer about 18 inches thick of fine cement concrete, then about three feet of rough concrete full of large gravel, then brick, supporting arches or vaulting.

METHOD OF WORKING

A large hole was first cut with the aid of the drills through the top of one of the arches, and a wooden chute was constructed to the space below: the roadway was then cut away above and below the hole and the muck shoveled down into a wagon placed below the chute. The material was cut away in layers or benches; first the top layer of fine concrete which, though hard, was fairly uniform and good cutting; then the rough concrete, which



FIG. 2.

was very hard on the drill bits and taxed the capacity of the drill to the utmost, and lastly the brick, which was comparatively easy cutting. In one instance it was found necessary to cut through a steel tie to allow room for a heavy girder. This was done with the same drill steel as used for the concrete and was accomplished in the surprisingly short time of



FIG. 3.



FIG. 4. I BEAM CUT OFF BY BUTTERFLY DRILL.

12 minutes. In another case the anchor bolts of the elevated structure had to be cut; the "Butterfly" Drill was so light and easy to handle, and the vibration was so slight that this was almost as easily accomplished as with a chipping hammer specially designed for that class of work.

The air was supplied by an Ingersoll-Rand Class "A" air compressor pumping to 110 lbs. at the receiver and giving 90 lbs. at the drills.

The air after leaving the main pipe line was brought through a coil of pipe, made up of elbows and short lengths of straight pipe suspended over a fire bucket, this constituting a simple though hardly economical reheater from the bottom of which the hose connections were made: this reheating was done more for the sake of adding a little to the available air volume than for preventing freezing at the exhaust of the drill, as the "Butterfly" valve used on this drill is non-freezing.

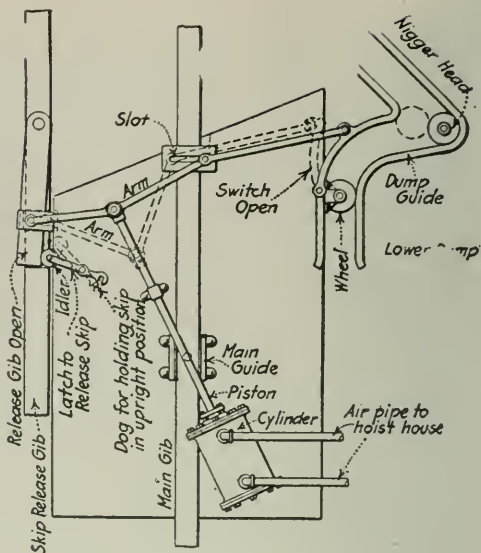
The steel used was solid hexagon. The first bit tried out was a regular chisel or "bull" bit rather spread at the edges. This was found unsatisfactory and was changed to a narrow pointed chisel about $\frac{3}{4}$ inch across the cutting edges dressed with the flat side on the corner of the hex, so as to present the strongest section of steel when used as a lever.

It is impossible to state at this time just how fast the work is done with the "Butterfly" Drill, as it constantly varies in character and there are no records of similar work with which to compare it.

COMPRESSED AIR DUMP CONTROL

BY J. R. MC FARLAND.

The Giroux Consolidated Mines Co. at Kimberly, Nev., has recently changed from cage to skip hoist. As it was desired to get the greatest possible production from the shafts considerable care was used in designing the dumping arrangement. The peak load of the day in the hoist room is after dinner. Almost the entire work of hoisting rock is done in the two or three hours before the shift goes off. As the rock is composed of both ore and waste it must be handled with discretion.



In order to avoid wasting time by having the skip dump into one chute and having a man climb up into the headframe and adjust a gate so as to direct the material into the ore bin or waste bin as the case requires, a new arrangement was made. Two bins are built. The lower one is for waste and the upper one is for ore. The man at the bottom of the shaft gives a signal by pulling a rope which rings a bell in the hoisting room. The signal designates a skip of ore or one of waste as the case may be, ready to be hoisted from the bottom. If it is a car of waste the engineer, by the operation of a lever at his side, controlling air to the dump machinery, closes a switch in the lower dump guide and releases a latch on the skip allowing the skip to swing at its center on the main guide. Thus the waste is dumped into the lower bin. If it happens to be a car of ore, by the operation of the same lever, he opens the switch in the lower dump guide, allowing the guide wheel to pass through, and at the same time the release gib is held closed so as to maintain the upright position of the skip. The skip thus passes through the lower dump and dumps the ore into the upper bin.—*Eng and Min. Journal.*

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

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We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

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AIR AND THE ROCK DRILL

From the beginning the rock drill has quite persistently insisted upon having compressed air to drive it. It does, indeed, do good work, but never quite its best work, when driven directly by steam; but the greater portion of its work, and that its most responsible work, has to be done where the use of steam is impossible, and thus while nothing but air will satisfy it nothing could serve it better.

The services of the air in connection with rock drill driving include two separate functions: first the transmission of the power, often for considerable distances, from the source of the power to the point where the work is to be done; and, second, the employment of the air in the actual doing of the work.

As a transmitter of power compressed air has a successful and pushing rival in the electric current; in fact where long distances are involved or where the work is distributed over large areas, the electric drive offers the engineer great inducements. It transmits the power so well and so cheaply, why may it not also actually do the work when it gets there?

To one not sufficiently familiar with the conditions under which rock drilling must generally be conducted it would seem to be a simple mechanical problem to produce some combination of electric motor and drilling tool which would be practical and efficient. Those who have had to meet the operative conditions of service in rock drilling, however, have not been so sanguine, and all their experience has been discouraging. The rough-and-ready service which an elastic medium, such as compressed air, can provide, meets the working conditions in a manner which has not been found practicable when the electric motor is mounted directly upon the jarring and pounding machine; while the general adaptability of the modern rock drill, the property which has really made its success largely possible, is the result of a flexibility and elasticity, combined with details of mechanical construction, which have been evolved in the hard school of experience.

The call for the electric drive for the rock drill has been so insistent that it would have been a wonder if something had not come of it. The seemingly impossible has been completely accomplished, and both electricity and

compressed air may be said to have won. The electric air drill is more completely an air operated drill than any of its predecessors, for not only is air its actuating fluid, but it is so exclusively, since it would be impossible to work the drill by steam, and it is also entirely electrically driven since all the connection it has with the power house are the wires right up to the mechanism.

With the advent of the electric air drill it becomes possible to use only the one power transmission for extensive engineering plants with a variety of apparatus to be operated. There is no question at all about the electric drive for hoists, conveyors, stone crushers, concrete mixers, pumps and the rest, and the electric air drill makes the big compressor and the costly pipe lines in many cases superfluous.

A CONFIDENTIAL EMPLOYMENT DEPARTMENT

It has been determined to open in the columns of COMPRESSED AIR MAGAZINE a confidential employment department which shall be of service to both employers seeking assistance in the conduct and execution of their work and to competent and experienced men capable and desirous of filling such positions. A large part of the work for which compressed air furnishes the power is of a more or less temporary character, as in tunneling, shaft sinking, general engineering and construction, and often also in mining and quarrying. There are new undertakings constantly beginning and others coming to a finish, and between these there are new arrangements to be made which often leave both employers and those seeking employment out of touch, and we would be glad to be instrumental in bringing these together for the benefit of all concerned. This department may be regarded as at present a more or less experimental one, but it is purposed to give it a fair trial. We assume no responsibility except to use our best judgment as to credentials of those whose names appear on our list. We make no charge for our services and we can only give the addresses of those listed to any who may require them. We cannot undertake to carry on correspondence. Those wishing addresses will please refer to them by their numbers.

1. Wants to take charge of underground

work. Was for several years head mining captain in a Michigan mine.

2. Has held position as superintendent of mines in Colorado.

3. First class operator of Leyner drill sharpener. Repairs drills.

4. Compressor engineer or to take charge of plant. West preferred. Now employed.

5. Channeler runner and general mechanic on quarry work.

6. Salesman or to take charge of machinery business. Experienced machinist.

7. Speaks and writes Spanish and familiar with Portuguese. Tunnel man familiar with drills and air machinery. Has successfully conducted railroad work in Brazil.

8. Graduate of Mich. College of Mines, 1909, and actively employed in mining service ever since. At present superintendent of prominent copper mining company. Will consider similar position.

9. Graduate of Michigan College of Mines. Has been superintendent of large mine several years, still holding the position. Thoroughly competent to handle large mining proposition.

DANGERS OF COMPRESSED HYDROGEN

The explosion of tubes of compressed hydrogen, accidentally contaminated with air, on connecting with a manometer to measure the pressure, has been investigated by Lalarge, who has found that if ordinary manometers are employed in the usual way, such explosions may occur whenever the hydrogen contains enough air to render it explosive, and the pressure is sufficiently high. The reason probably lies in the rise of temperature produced by the sudden and more or less adiabatic compression of the air in the manometer. Such accidents may be avoided by interposing, between the tube of compressed gas and the manometer, a safety-tube containing disks of metallic gauze of such mass that they are not appreciably heated by combustion of the gas mixture in the manometer. By this means the ignition of the main body of gas is prevented. Similar safety tubes should be employed whenever a highly compressed explosive gas mixture is allowed to expand suddenly into a confined space. Before measuring the pressure of compressed hydrogen, liable to contain air or oxygen, it is advisable to determine its density, as a further safeguard.

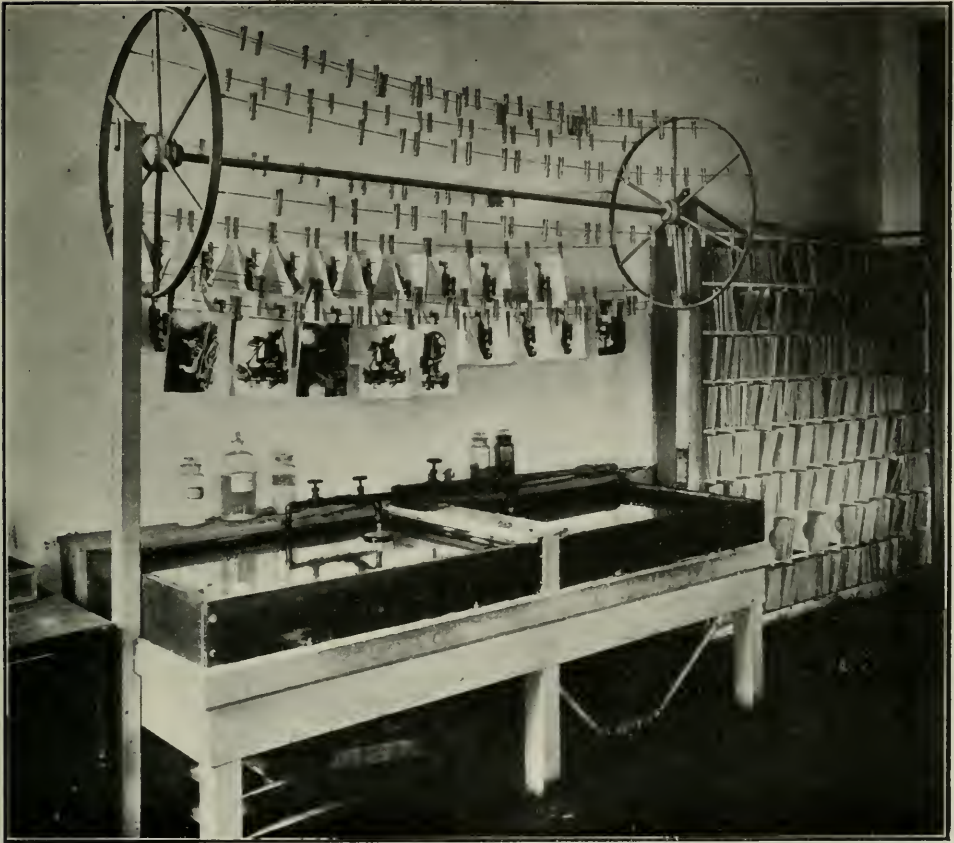


FIG. 3.

PHOTOGRAPHY IN PNEUMATIC TOOL AND AIR COMPRESSOR PLANT

There is presented in what follows a brief description of the photographic practices followed by the Ingersoll-Rand Company. This company maintains an extensive photographic department as an adjunct of its publicity bureau at Easton, Pa., and its experiences and methods may be offered in further explanation of the facilities provided for utilizing photography in large industrial organizations.

Like others which have a large and varied line of product, the Ingersoll-Rand Company finds the use of the camera by its own experts of almost indispensable value not only in connection with the preparation of its catalogues and descriptive literature, but in other directions as well. The output of the photographic department of the company may be divided into five classes as follows: 1.—Shop pictures.

2.—Reproductions of wash drawings, tracings, line drawings and retouched photographs. 3.—Bromide enlargements for framing. 4.—Out-

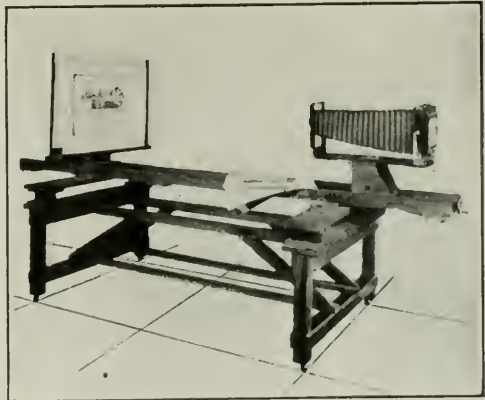


FIG. 2.

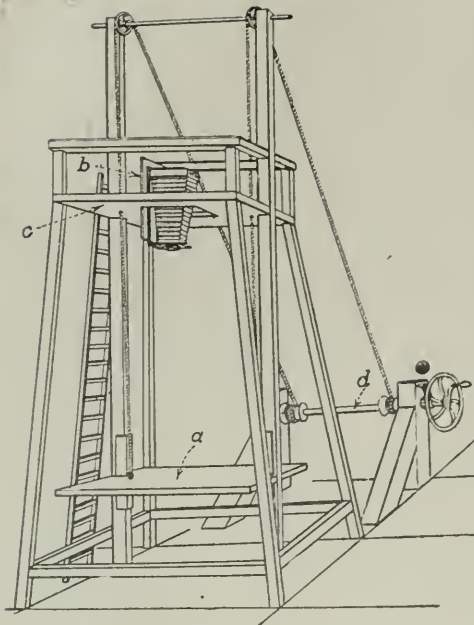


FIG. 1.

side views and installations. 5.—Lantern slides.

In the execution of their work and in devising apparatus to obtain the best results the photographers of the Ingersoll-Rand Company have exercised ingenuity as well as skill. Tak-

ing up in their order the various classifications alluded to, many interesting points may be touched on in even a sketch of the methods.

When it has been determined in the preparation of a catalogue what illustrations are to be used, the photographic department is authorized to take the necessary pictures, the detail and arrangement of the subjects being made to conform with instructions given with the order. Each particular line of machinery is photographed in the department producing it, and the shop engineers assist in arranging the machine and parts to insure the showing of all essential details.

In all shop photography many difficulties are encountered, and these are often accentuated in the case of the Ingersoll-Rand Company because its products include large machines which are too heavy to permit of easy rehandling. Consequently some machines must be photographed on the erecting floor just as assembled under conditions which are anything but satisfactory because of poor light, close quarters, etc. Under such circumstances a good lens, equally good judgment and a correct use of flashlight powder are essential to good results. The company's photographers also make use of a muslin or canvas curtain fastened on a wire and supported at either end by wooden poles 10 or 12 ft. high for a back-

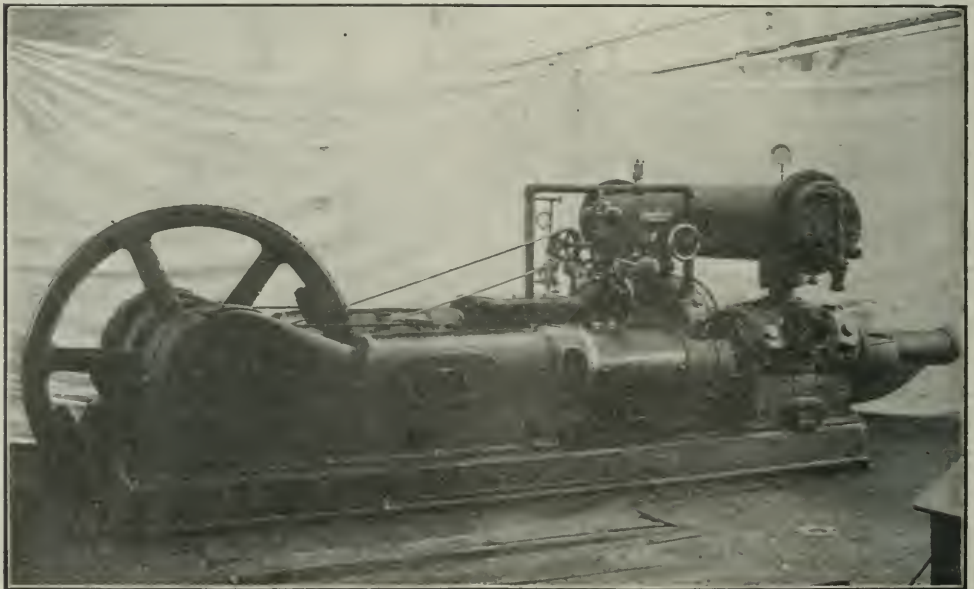


FIG. 4.

ground as shown, for example, in Fig. 4. Flashlight powder and flashlight bags are located in such positions as will light up the dark recesses and bring out details. Here, it may be said, good shop photography requires an assortment of high-grade lenses to prevent distortion and get correct perspective. In their work of making pictures at close range the Ingersoll-Rand photographers use lenses averaging from $7\frac{3}{16}$ to $23\frac{3}{8}$ in. in focal length.

Duplicate part photographs, used by some firms in the making of what are called "renewal sheets," involve another use of the camera in the making of shop pictures. In the production of these the Ingersoll-Rand Company uses an adjustable frame, Fig. 1, which has been found to work very successfully. The parts are arranged in proper rotation on platform *a*, and the camera is attached to support *b* on the platform *c*. To accommodate the changing quantities of parts on various pictures, platform *a* is made adjustable and can be raised or lowered by means of the windlass *d*, to suit conditions. It is advisable to locate a frame of this kind in the open so as to get the best light possible.

The value of the camera in the copy room of the publicity bureau is great as it is regarded as indispensable in reproducing. After the air brush artist completes a wash drawing it is sent to the copy room and photographed in a convenient size for distribution. Line drawings, tracings and retouched photographs are given the same treatment. The room in which this work is done must have a sufficient number of windows to afford good lighting, and the windows must be equipped with shades in order that the light may be controlled. Fig. 2 shows a camera stand used in the copy room and for so-called process work is declared to be a necessity. The tracings or drawings are mounted on frame *A*, which is constructed to permit its being moved in any direction by means of conveniently located handles, making it easy to bring the axis of the lens into correct relation with the position of the subject. The stand is strongly made of 2 in. material with steel springs for absorbing the building vibration, and heavy castors to allow of its being moved about with ease. The grooves in bed *B* are accurate in alignment so that the camera (which is mounted and fastened on frame *C*) and frame *A* can be moved back and forth with little effort.

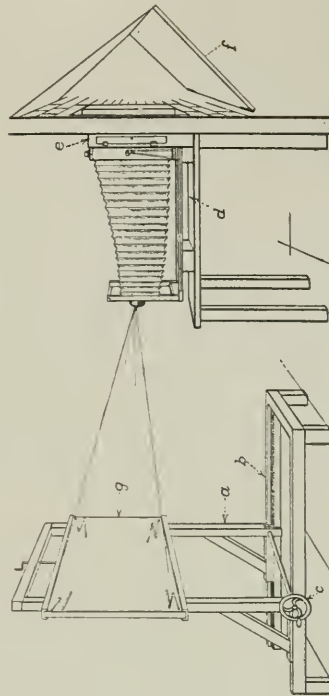


FIG. 5.

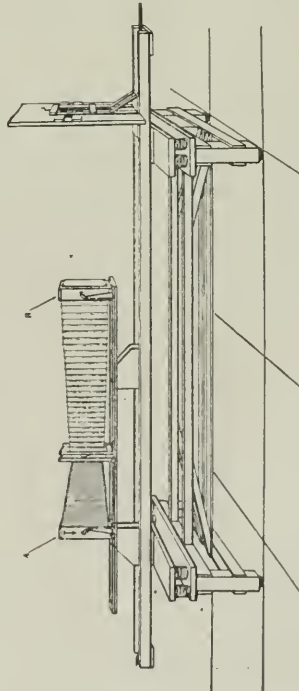


FIG. 6.

A specially designed apparatus for producing bromide enlargements with daylight is shown in Fig. 6, its construction being not dissimilar to that of Fig. 1. The stand *a* is made adjustable and can be moved back and forth on bed *b* by means of hand wheel *c*. The camera is mounted on platform *d* so that the back fits tightly in aperture *e*. A reflector *f* is located at a 45 degree angle to reflect the light into aperture *e*, from which it passes through the negative, reflecting the image on sensitized paper mounted on board *g*. With the frame *a* adjustable, it is possible to produce any size enlargement, although an 18 by 22 in. size has been found large enough for most requirements. With this arrangement it is understood, of course, that no light falls on the sensitized paper except that which forms the image, the room otherwise being in total darkness.

In the production of photos for the company there is need for many power-house views showing installations of air compressors, and underground photographs showing drills and other machines in operation in tunnels, subways and coal and metal mines. Underground photography presents many obstacles foreign to any other field, but while special apparatus has sometimes been found necessary, in a general way the only equipment needed is a good camera outfit and flashlight apparatus.

Lantern slides for use in lecture work such as the presentation of the subject of pneumatic tools in foundries and other industries are made in the copy room on a camera frame illustrated in Fig. 5. Two cameras, A and B, are placed on the frame with the fronts adjoining. The lens is mounted on camera A which is fitted with a special detachable back for holding the lantern slide plate holder. The 8x10-in. negative is placed in the back of camera B. Directly back of this and far enough away to be out of the focal range the copy board C reflects a uniform light on the negative from a white cardboard tacked to it. By proper manipulation of the two cameras the negative image is reduced and converted into a positive lantern-slide transparency.

In Fig. 3 is shown the washroom of the photographic department where prints are washed, dried and trimmed. The washline apparatus mounted on the two poles will conveniently accommodate 200 8x10-in. prints if they are pinned on the line back to back.

COMPRESSED AIR FOR COOLING IN DRILLING DEEP HOLES IN STEEL

It is generally recognized that compressed air can be used as a cooling medium for drilling cast iron, but there are few mechanics who would advocate its use for machine steel. It may be interesting, therefore, to record an application of compressed air to deep hole drilling in machine steel, which is being put into use in the plant of the Dayton Motor Car Co., Dayton, Ohio.

The piece to be drilled is a piston pin made from round bar stock containing from 0.20 to 0.30 per cent. carbon. This piston pin is machined in a 1¼-inch Cleveland automatic screw machine, which is fitted up with the regular oil feed arrangement for the turret tools, but instead of forcing oil through the piping, compressed air of 75 pounds gage pressure is used.

The drill used is a regular fluted high-speed steel oil-tube drill, ground on the cutting edges so as to break up the chips. A long curling chip would be difficult to remove, as it would twist around the flutes of the drill. The most interesting point about this operation is that the drill is not withdrawn from the work until it has been forced in the desired distance—5 inches—at a steady feed of 0.015 inch per revolution, and a surface speed of about 70 feet per minute. This surface speed is much lower than that which a high-speed steel drill will stand, but it has been found that a heavy feed with a lower surface speed gives the best results, as it produces a chip which is easily blown out.

The chips which are blown out by the compressed air are quite cool and can easily be held in the hand. The hole produced is smooth as compared with that obtained when oil is used as a lubricant. A good grade of lard oil was used on this job before compressed air was tried, but the oil proved unsatisfactory as the drill would bind and heat up before the lubricant reached the bottom of the hole. It seems that the oil made the chips adhere to each other and thus prevented them from being washed out of the hole, while on the other hand the chips are kept clean and cool by the compressed air and are blown out just as soon as they are removed by the drill.—*Machinery*.

FOAM AS A GASOLINE FIRE EXTINGUISHER

Water, it is well known, serves only to increase a fire in petroleum products, although it is effective against alcohol fires. Exclusion of air is the only means of effectively extinguishing an incipient blaze in gasoline, benzene or oil. In the method invented by Laurent in Germany, which has recently been officially tested, the agent employed is foam. A solution of sodium carbonate mixed with foam-producing substances, and a solution of alum, combined in equal parts, produce, without precipitation of any solid, a thick, yellowish-white foam, which can be pumped and sprayed as effectively as water. A mixture of one litre (0.264 gallon) of each of the solutions produces 15 litres (3.96 gal.) of foam weighing 140 grammes per litre (18.6 ounces per gallon). Sprayed on a burning liquid, the foam, as it accumulates, spreads gradually over the whole burning surface, effectively shutting out the air and thus extinguishing the fire. As to its efficiency in extinguishing fires, two typical results of the tests may be quoted. A fierce blaze in a tank of benzene 40.35 sq. ft. in area and 20 in. deep, was extinguished in 78 sec. In another case, with a larger expenditure of chemicals, only 13 seconds were required to quench a fire in another tank 6.56 ft. in diameter and 8.5 ft. deep.

FOR THE ELECTRIC APPLICATION OF AIR BRAKES

At the January meeting of the New York Railroad Club, a paper was presented advocating the use of an electrically controlled air brake for steam railway service. While special emphasis was placed on the greater rapidity of application that can be obtained at the rear of a long train, by means of such a control, the advantages to be gained were not considered to be those of decreasing the distance run in making the stop, but in the reduction of the shock incident to the present method of brake application, because of the greater uniformity in the retardation of all the cars of the train. The first advantage to be gained would, therefore, lie in the elimination of rough stops. Then, as shocks are decreased, so would be the tendency of the wheels to slide flat. The discussion was directed more particularly to passenger train work, but the use of such a brake on freight trains also was advocated on the

ground that there would be a great reduction in shock, and consequently in damage to cars and lading, if the time of application of brakes to the last car of a 100-car train were to be cut down to a simultaneous application to all of the cars from the present required time of 6 or 7 seconds.

NOTES

At the meeting of the American Society of Agricultural Engineers, Eugene Becker brought out the fact that explosive mixtures of gas and air are formed as follows: Gasoline vapor 2 to 5 per cent., air 98 to 95 per cent.; acetylene 2 to 49 per cent., air 98 to 51 per cent.; blow-gas 4 to 8 per cent., air 96 to 92 per cent.; which shows why great care must be exercised in handling acetylene gas to avoid explosions.

A suspension bridge much longer than any yet erected is proposed to span the Mersey at Liverpool. The main dimensions are as follows: Main span, 2,700 ft.; towers, 500 ft. high; height above high-water mark, 200 ft.; depth of girders, 50 ft.; weight of girders, 2,100 tons; width between girders, 50 ft.; width between towers, 300 ft.; and weight of cables (410 sq.in. in each), 6,400 tons.

Two horses weighing 1,600 pounds each, together pulled 3,750 pounds or 550 pounds more than their combined weight. One elephant weighing 12,000 pounds pulled 8,750 pounds or 2,250 pounds less than its weight. Fifty men, aggregating 7,500 pounds in weight, pulled 8,750 pounds, or just as much as the single elephant; but, like the horses, they pulled more than their own weight. One hundred men pulled 12,000 pounds.

Forty minutes after they had been declared dead from suffocation seven out of twelve firemen recently overcome by smoke and gas during the destruction of the Westinghouse electric plant by fire in Pittsburgh, Pa., were revived by pulmotors at a hospital, and owe their lives to this life-saving invention. The Bureau of Mines has a full equipment of pulmotors for its life-saving crew, and they proved successful in many instances.

Some large turbo-compressors are now in successful operation in Germany. One of these installed at the Reden mine, near Saarbrücken,

runs at 4,200 r. p. m. and compresses over 4,000 cu. ft. of free air per min. to 90 lbs. gage. Another, installed in Westphalia, runs at the same speed with a capacity of 6,000 cu. ft. of free air per min. delivered at a pressure of 105 lbs. gage. The efficiency of the compressor, compared with isothermal varies between 64 and 65 per cent.

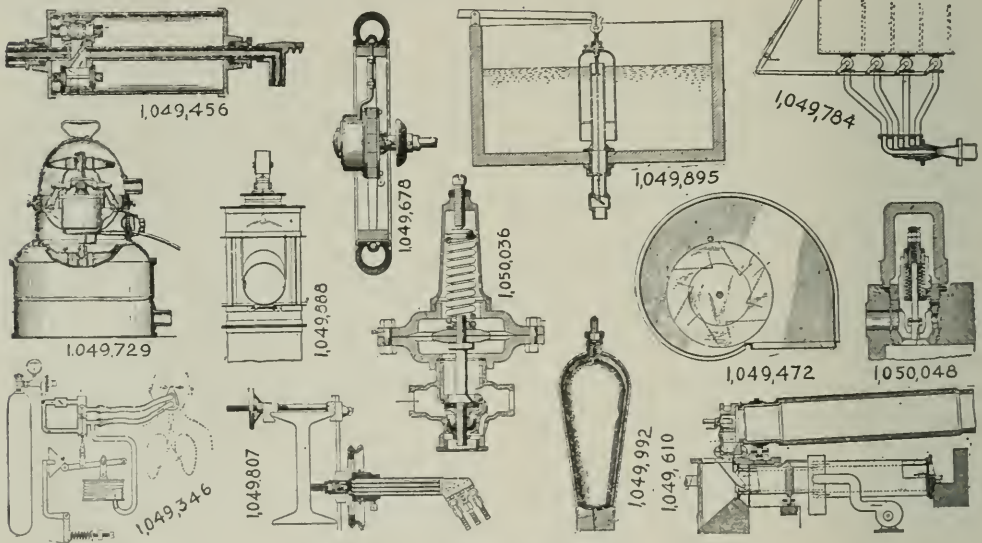
A current of dry air will evaporate and absorb water at any natural temperature, the only condition being that the dry air be renewed as fast as it becomes saturated. Solid water—ice—will evaporate in a current of dry air although the temperature may be below the melting point of ice.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JANUARY 7.

- 1,049,346. ARTIFICIAL BREATHING APPARATUS. JOHANN HEINRICH DRAGER, Lubeck, Germany.
 1,049,443. PNEUMATIC PIANO - PLAYER. FLOYD W. BORDNER, Toledo, Ohio.
 1,049,456. RECIPROCATING FLUID-PRESSURE MOTOR. PETER T. COFFIELD, Dayton, Ohio.
 1,049,472. FAN OR BLOWER. HENRY P. GALE, Chicago, Ill.
 1,049,610. ROTARY COOLER FOR CEMENT CLINKER. AXEL SCHAFFER, Copenhagen, Denmark.
 1,049,677-8. COOLING DEVICE FOR PNEUMATIC TIRES. ANDREW B. CRAIG, Tarkio, Mo.



PNEUMATIC PATENTS, JANUARY 7.

Systematic water waste surveys conducted in Chicago, Memphis, Yonkers, Indianapolis, Washington and New York City have brought to light an immense number of underground leaks running continually into nearby sewers, without showing at the surface. In the city of Washington alone, in the past five years, a total of 30,000,000 gallons daily from about 3,000 underground leaks were found, chiefly in mains and service pipes, none of which showed above the ground. A new water supply of this amount would have cost \$5,000,000, plus extra operating expenses for the new plant, while the stopping of these leaks actually reduced the operating charges.

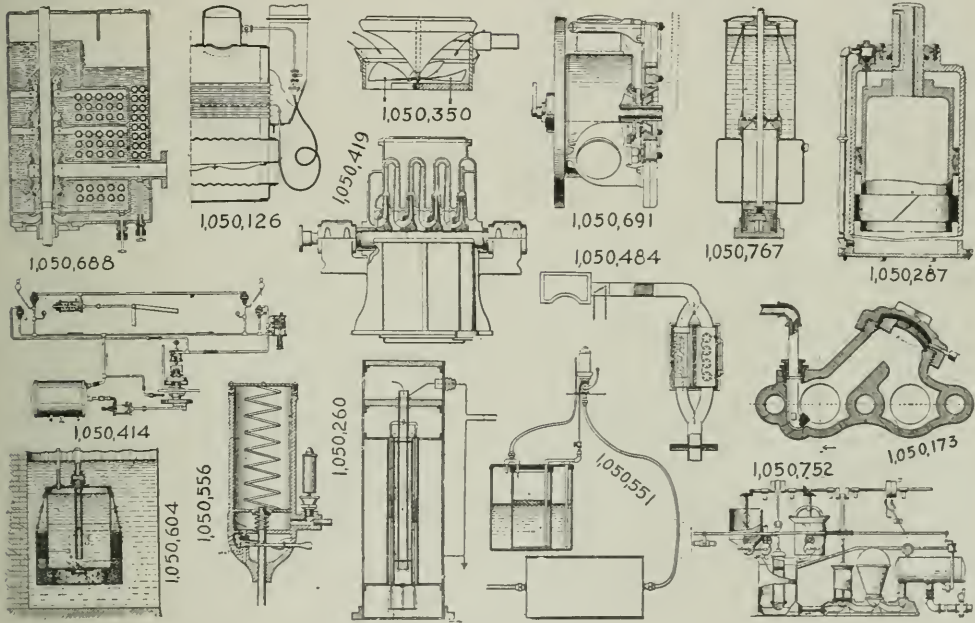
- 1,049,729. SUCTION-CREATING PUMP FOR CLEANING AND SCRUBBING MACHINES. CHARLES A. KAISER, Philadelphia, Pa.
 1,049,784. ELASTIC-FLUID TURBINE. PAUL WAGNER, Charlottenburg, Germany.
 1,049,807. ROTARY - BLOWPIPE APPARATUS. WORTHY C. BUCKNAM, Jersey City, N. J.
 1. In a device for the circular cutting of beams, rails and other bars by means of gases, the combination of a supporting structure having suitable means for attachment to the bar, a circular carrier supported thereby and having transverse holding and guiding means, means for rotating said carrier, and gas cutting means on said carrier adjustable relatively to the axis of rotation on said holding and guiding means.
 1,049,888. AIR-LOCK FOR CAISSONS. SAMUEL MATTSON, New York, N. Y.
 2. An air lock for caissons consisting of a cylindrical casing having an opening in its side, and a concave roller mounted on said casing at the bottom of said opening, for the purpose stated.

- 1,049,895. SIPHON FLUSHING APPARATUS JOHN J. MEYER, Yonkers, N. Y.
 1,049,992. AUTOMATIC AIR-VALVE. BOB CATCHINGS, Jasper, Ala.
 1,050,013. APPARATUS FOR TREATING GASES AND VAPORS TO THE ACTION OF LIQUIDS. CHARLES HOWARD FOWLER and EDWARD ARNOLD MEDLEY, Great Crosby, England.
 1,050,036. FLUID-PRESSURE REDUCER OR REGULATOR. HENRY MUELLER, deceased, Decatur, Ill.
 1,050,048. COMPRESSOR-VALVE. WILSON A. ZIMMER, Cleveland, Ohio.

JANUARY 14.

- 1,050,126. FLUID-JET BLOWER. TEODORO GRUENWALD, Genoa, Italy.
 1,050,173-4. SANDER. WALTER B. ROGERS, Knoxville, Tenn.
 1,050,260. OZONE-GENERATOR. ALBERT E. WALDEN, Baltimore, Md.

- trolling the passage of fluid-pressure through said conduit, and a conduit leading from the second named conduit, at the opposite side of the valve with reference to the source of fluid-pressure supply, to the interiors of the containers, whereby opening of the valve will cause sounding of the audible signal and a synchronous emission of visual-signal means from the tube.
 1,050,556. FLUID-PRESSURE-RELEASEABLE LOCK FOR FREIGHT-CAR DOORS. GEORGE VANCE MCGILL, Albion, Pa.
 1,050,604. AIR-LIFT FILTERING-PUMP. CONRAD E. BIEL, Denver, Colo.
 1,050,688. ROTARY AIR-PUMP. JOSEPH PETERMOLLER, Holm Foundry, Cathcart, Scotland.
 1,050,691. FLUID-PRESSURE ENGINE OR PUMP. CHARLES BENJAMIN REDRUP, Canton, Cardiff, England.
 1,050,752. MEANS FOR SUPPLYING A SPRAYING FLUID UNDER PRESSURE. ROBERT MURTON POOLE, Mount Gambler, South Australia, Australia.



PNEUMATIC PATENTS, JANUARY 14.

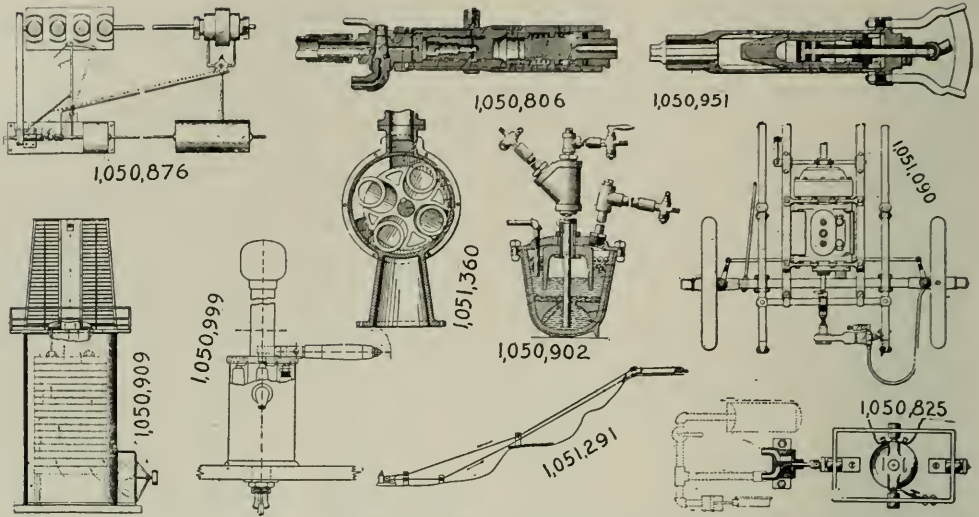
- 1,050,287. AIR-CYLINDER. JOHN J. OLSON, Superior, Wis.
 1,050,350. ANEMOMETER. HENRY DAVIS, Derby, England.
 1,050,372. ELECTRIC AIR-HEATING DEVICE. FRANK P. MIES, Chicago, Ill.
 1,050,414. AIR-BRAKE AND APPURTENANCES FOR VEHICLES. EDWARD W. WOOLLEY, Jersey City, N. J.
 1,050,419. CENTRIFUGAL COMPRESSOR. OTTO BANNER, Easton, Pa.
 1,050,484. AIR-TEMPERING DEVICE. MIN DE LIN MCGERRY and FRANK P. MIES, Chicago, Ill.
 1,050,551. VISUAL SIGNAL. STEPHEN J. KUBEL, Washington, D. C.
 1,050,767. AIR-PUMP. HENRY ALBERT FLEUSS, Thatcham, England.

JANUARY 21.

- 1,050,806. ROTATOR FOR ROCK-DRILLS. CHARLES T. CARNAHAN, Denver, Colo.
 1,050,825. AUTOMATIC AIR-BRAKE CONTROL. MAX K. GROSSHEIM, Jersey City, N. J.
 1,050,876. FLUID-PRESSURE SYSTEM AND AUTOMATIC GOVERNOR THEREFOR. FRED S. VAUGHN, Chicago, Ill.
 1,050,892. BLOWER. EDGAR C. WILEY, Lynchburg, Va.
 1,050,902. ECONOMIC METHOD OF OBTAINING GASES. CHARLES E. ACKER, Ossining, N. Y.

1. In a signal means, the combination of an audible signal, a tube arranged adjacent thereto and disposed to discharge upward, a source of fluid-pressure supply, containers, a conduit intermediate the containers and said tube, chemicals in said containers, adapted when commingled to form a signal-means visible in the atmosphere, a conduit intermediate the source of fluid-pressure supply and the audible signal, a wave con-

1. The process of obtaining a gaseous element from a fluid containing oxygen as one of the constituents thereof, which comprises reacting upon a heated mass of metal, having a strong affinity for oxygen, with the oxygen content of a quantity of said fluid, separating the element sought from the compound so formed, disseminating said compound through a mass of liquid



PNEUMATIC PATENTS, JANUARY 21.

conveying medium having characteristics different from those of said compound, conveying said compound through the instrumentality of said medium to points relatively remote from where said gaseous element is being separated in manner aforesaid, and reacting at said remote points upon said compound with a reducing reagent to reform the metal.

1,050,909. LIQUID-COOLING APPARATUS.

FERDINAND BAUER, St. Louis, Mo.

1,050,951. PNEUMATIC HAMMER. VILHELM

PHILIP KESSEL, San Francisco, Cal.

1,050,999. APPARATUS FOR AERATING LIQUIDS. HUBERT PEARCE, Wanstead, and WILLIAM BARRATT, Muswell Hill, England.

1,051,090. AIR-PUMP FOR INFLATING AUTOMOBILE-TIRES. JOHN DESMOND, Chicago, Ill.

1,051,291. PNEUMATIC SNUBBING MEANS. HARRY L. TURNER, Portland, Oreg., and HENRY A. KALB, Ramond, Wash.

1. In a snubbing device, the combination with the two drums of a hauling engine; of a pneumatic means for controlling the speed of the device; and a single hauling cable having one end fixed on one of said drums, from which it extends to a sheave of said controlling means, making a few turns around said sheave and thereupon returning to the second drum of said hoisting engine.

1,051,304. PNEUMATIC ACTION. CHRISTIAN ALTER, New York, N. Y.

1,051,360. AIR-PUMP. GEORGE P. WISDOM, Denver, Colo.

JANUARY 28.

1,051,406. EXHAUST-REGULATING VALVE FOR PNEUMATIC PLAYER-ACTIONS. EMORY C. HISCOCK, Chicago, Ill.

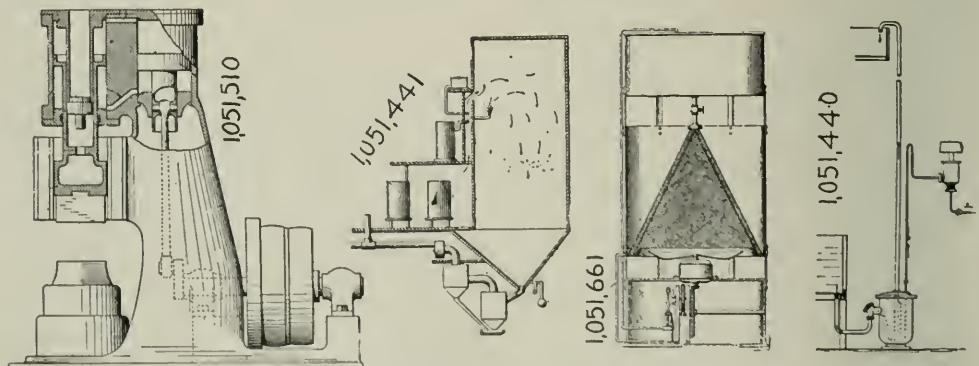
1,051,441. OBTAINING DRY SOLIDS FROM LIQUID SUBSTANCES. GEORGE H. PALT-RIDGE, Washington, D. C.

1. A process for drying liquid substances, which consists in supplying air to an air chamber, spraying atomized fluid into the upper part of the chamber and permitting it to drop downward while being dried by the air, and in discharging the entire air, vapor and solid contents of the chamber together at the same point in the bottom of the chamber.

1,051,510. FLUID-POWER HAMMER. JOHN NAZEL and RALPH E. BATES, Philadelphia, Pa.

1,051,540. COMPRESSED-AIR DISTRIBUTING OR REGULATING DEVICE FOR PULSOMETERS AND SIMILAR APPARATUS. JOHANN BERNING, Dusseldorf, Germany.

1,051,661. AIR-COOLER. ALBERT ANDERSON, Deer Wood, Minn.



PNEUMATIC PATENTS, JANUARY 28.

COMPRESSED AIR

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THE LOOKOUT AT LOOKOUT MOUNTAIN TUNNEL.

MINE AND TUNNEL EQUIPMENT WITH REFERENCE TO CERTAIN MINES AND TUNNELS

BY CHAS. A. HIRSCHBERG.

Time has wrought many changes in the means and methods employed in mining and tunneling projects, and it is doubtful if any

but those who have watched the transitions all through really appreciate the advance that has been made towards greater speed and economy of operation.

From the crude and cumbersome devices of the early inventors there has been evolved the efficient one-man drill of to-day, such as the



FIG. 1. LARAMIE TUNNEL PORTAL.

Butterfly, the Leyner, the Jap and the Jack-hamer, tending to materially reduce the item of drilling labor, not alone in mines, but in tunnels, even where it has been found necessary to employ more than one drill in a heading, involving therefore heavier mounting equipment; as for instance, in the Laramie Tunnel, Figs. 1 and 2, where three such light

drills were used on a horizontal bar the three runners being provided with two helpers in place of the usual three, as was the practice in the past with the heavier types of drills and the column mounting as seen in Fig. 3 then available. And the use of such drills in this manner has been accomplished without the sacrifice of speed; on the contrary, coupled



FIG. 2. LARAMIE TUNNEL HEADING.

with other advanced features of design, they have proven a material aid in increasing actual accomplishment far beyond early expectations.

In the first type of drills mentioned above some of the principles involved in early construction have been retained; in the latter a distinct departure from former design has been made. This has been accomplished by the employment of the "hammer" principle, in which the drill steel is not reciprocated but is pressed against the rock resting loosely in the chuck and is struck by a light, rapidly

improved methods of sharpening. As already stated, along with these lighter, more rapidly drilling tools, times whirling has also seen methods of mining, tunneling and quarrying greatly revolutionized. In the early days it remained a matter of necessity that only those ores running high in value be saved, while the others were cast aside to await the better methods of treatment which have since been evolved.

It is interesting to note these changes. We no longer throw aside or pass over ore that

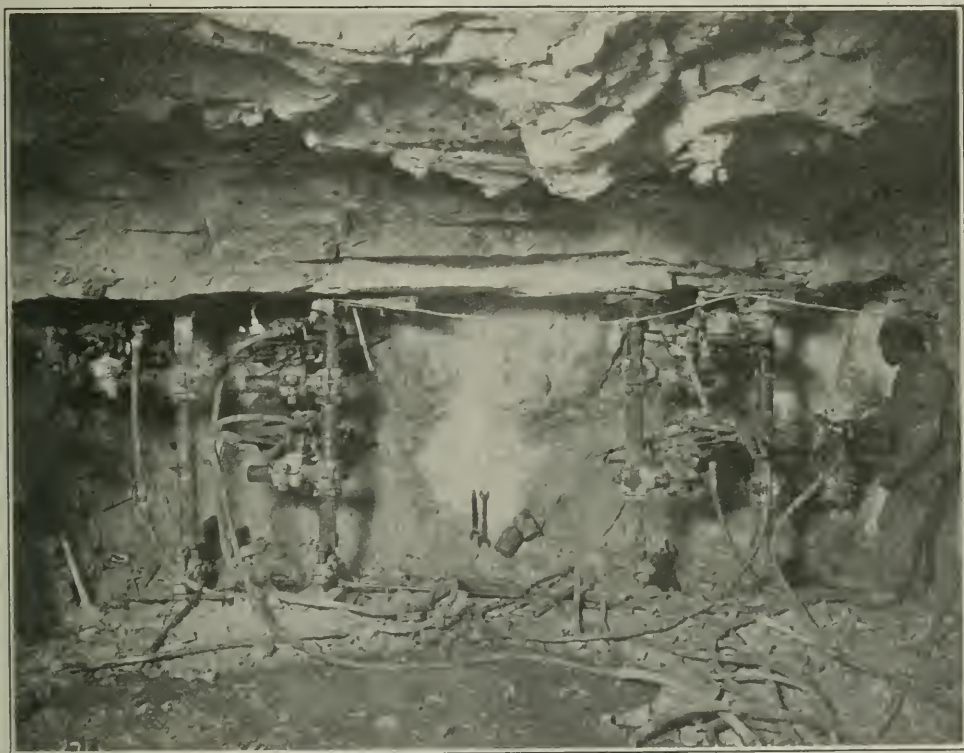


FIG. 3. HEAVY DRILLS AND COLUMNS.

moving piston, as opposed to the percussive type, in which the steel is rigidly connected to the piston and reciprocates with it.

These high speed tools called for other features not necessitated in former designs, such as automatic lubrication, self rotation, etc., carrying with it the need for improvements in metals, both cast and rolled, to meet the greater strains imposed upon them. Among these may be mentioned Tungsten-Vanadium, Nickel Steel and Irco metal. A demand was also created for high speed drill steel with

runs low in value; better methods and equipment, in both the mine and the mill, have made it profitable to utilize it.

In the mine we find the pneumatic feed drill supplanting the reciprocating types. This drill, used without mounting of any sort, finds its chief application in the excavation of large stopes or rooms, also in the following of narrow veins where economical excavation is entirely confined to the removal of the least amount of waste rock along with the ore.

The chief features commending this type

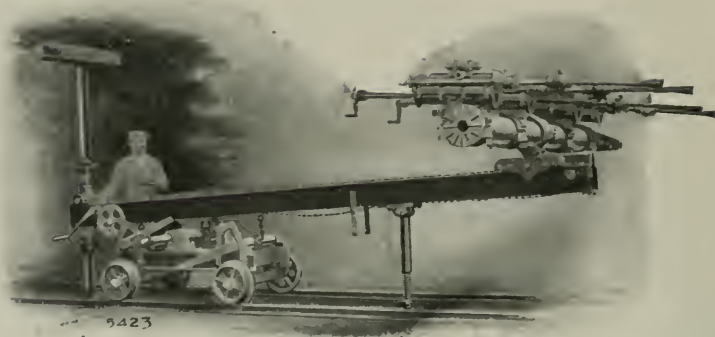


FIG. 4. TUNNEL CARRIAGE.

to the user are its ease of handling, its lightness and its rapid drilling qualities. Again we find the Jackhammer superseding mounted types of machines for shaft sinking purposes; as witness, the shaft of the Lucky Star Mining Co. in the Lake Superior region, where four of these little drills are at work in a shaft 12 feet 2 inches x 14 feet 10 inches drilling ten 6 foot holes for the sink and twenty 5 foot holes after blasting for the squaring. The progress has averaged 100 feet per month in very hard diorite. Also the Newport Mining Co., the size of shaft being 11 feet x 18 feet in the clear, the progress averaging 20 feet per week with five of these drills in hard quartzite. During February a progress of 107 feet has been reported.

The great advantage of their use in this

class of work is that the drilling never stops except for the shooting, the mucking and drilling going on continuously. In addition to their lightness and ease of handling the absence of all mounting facilitates the accomplishment of more work.

As important as these changes in the drilling equipment itself, improved methods of sharpening have appeared, more attention being paid to the shape and condition of the drill bits; the problem being largely solved by the introduction of compact and efficient power machine sharpeners, such as the Leyner. Better steel heating apparatus such as specially designed oil and coke furnaces, has also made its appearance.

With the advent of power sharpeners and special furnaces came the practice of installing



FIG. 5. ELIZABETH LAKE TUNNEL.

underground the sharpening plant, minimizing the number of steps and expense of handling large quantities of steels used by the mines of to-day with their miles of underground workings.

In tunnel driving we must not overlook the advent of the tunnel carriage (Fig. 4), as exemplified by European practice, greatly facilitating the quick set-up of a battery of heavy drills and their removal preparatory to blasting.

"With the use of these heavy drills and tunnel carriages the following records have been made:

"At the Simplon the average daily advance per heading was about 16 ft. at the Italian end and from 20 to 21 ft. at the Swiss end. This was in gneiss. In less difficult rocks an advance as high as 34 ft. in 24 hours was made.

"At Loetschberg yearly records per heading ran as high as 21 and 27.6 ft. per day, while for some the daily averages per heading were as high as 32.3 and 33.9 ft. with some beyond anything ever before achieved in tunnel driving.

"At Laramie, Mr. D. W. Brunton, in his paper presented at the San Francisco Meeting of the American Institute of Mining Engineers, in October, 1911, says:

"From March 1st to March 8th, 1911, inclusive, the tunnel was driven in a single heading, 192 ft., a daily average of 24 ft.; but the highest rate of progress was made during the last four days of January, 1911, when the tunnel was driven 112 ft. or 28 ft. per day; the record month being March, 1911, 653 ft. being driven.*

"The Alpine tunnels referred to were driven by the European system, and this Laramie Tunnel was driven by the American system; but the American system as used at Laramie involves a distinct departure, in that, instead of columns being used for mounting the drills, a horizontal shaft bar was used similar to that carried by the Alpine tunnel carriage, but with the distinct difference that the Laramie bar was a light, simple apparatus, only 3 in. in diameter, mounting three hammer drills, as distinguished from percussive drills."

*From discussion of paper read before the American Society of Civil Engineers, April 17, 1912.

These lighter one-man drills permit the use of a much lighter mounting, having been the cause of the adoption, largely in the western portion of this country, of the tunnel bar mounting in preference to the usual column and arm so much in vogue with the heavier type of drills. One advantage of this practice is that mucking operations may proceed without interfering with the drilling.

A notable instance of this practice has been the work in the Elizabeth Lake Tunnel of the Los Angeles Aqueduct (see Fig. 5) where a monthly progress as high as 604 feet of 12 feet x 12 feet tunnel advance was attained. This tunnel over 29,000 feet long, was driven entirely by the tunnel bar method using modern, light and rapid drilling machines.

INCREASE IN MACHINE MINING OF COAL

The number of machines used in mining coal in 1911 was 13,819, an increase of 565 over 1910. The leading coal producing state, Pennsylvania, is also first in the total tonnage mined by the use of machines and in the total number of machines in use; but in the proportion of machine-mined coal to the total output Ohio far outranks all other states. In 1911 Pennsylvania's production of machine-mined coal was 69,131,923 net tons, or 47.76 per cent. of the total. Ohio's production of machine-mined coal was 26,556,630 net tons, or 86.33 per cent. of the total. Ohio is third in the production of machine-mined coal, though ranking fourth in the total production. West Virginia is the second state in coal production, is also second in the output of machine-mined coal, which in 1911 was 29,121,480 net tons, or 48.67 per cent. of the total. Illinois is fourth in the quantity of machine-mined coal, with 23,093,807 net tons. In addition to the lessening of the mining cost, there are two other aims to be accomplished by the use of mining machines. The undercutting of coal by hand is one of the most exacting kinds of labor, and the use of machinery materially reduces the arduous tasks of the laborer. More important than this, however, is the greater safety secured through reducing the practice, too prevalent in many mining districts, of "shooting from the solid."

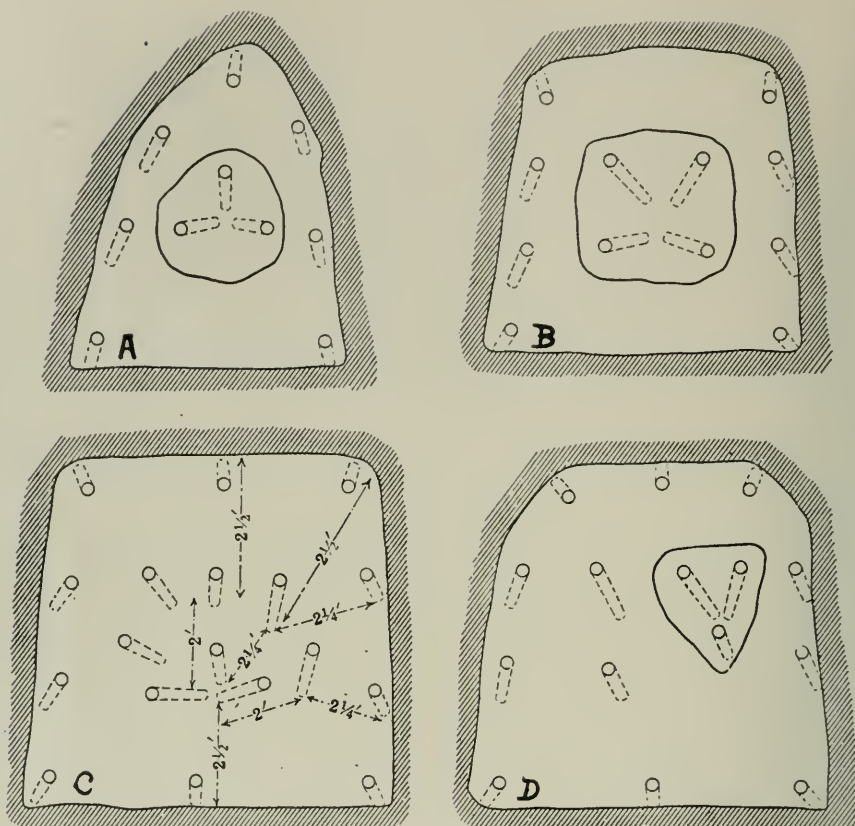


FIG. 1.

LAYOUT OF DRILL HOLES IN DRIFTS AND TUNNELS

BY FRANK RICHARDS.

Nothing can be more important in tunnel driving than an intelligent systemizing of the placing of the holes for blasting. Two important particulars are involved in this: the locating of the holes so that the explosion charges shall be most effective in breaking and dislodging the rock, and also the placing of them in such a way that the drills can be most conveniently placed and can do their work with the greatest rapidity and with as few and short delays in setting up and in making the necessary changes. Too often this matter has been left entirely to the miner and foreman, but more recently engineers and superintendents have been assuming the responsibility.

In works sufficiently protracted, as in the tunnels several miles in length, a system has gradually shaped itself, but only after the

wasting of valuable time in first finding out "how not to do it," and the system finally followed, or a better one, might have been earlier adopted and time might have been saved by systematic management at the beginning.

The general principles involved in the laying out of drill holes for tunnel work were discussed by Mr. P. B. MacDonald in the *Engineering and Mining Journal*, and an abstract of a portion of his article will be good to begin with, breaking into the matter without any preliminaries.

In Fig. 1 we begin with soft rock. A shows a 10 hole cut with one back hole, frequently used in driving small drifts where it is desired to keep the back well arched. The arrangement shown in B is suited to larger square drifts. These holes would not break much hard rock because of the distance between the bottoms of the cutting-in and the squaring-up holes.

These two classes of holes determine the shape of the drift. In hard rock there are in addition what are conveniently called relief holes, because, situated and fired intermediately between the cutting-in and the squaring-up holes, they relieve the ground to be broken by the latter set.

The most important rule to be observed in placing holes is that the determining factor is not the distance apart of the starting points of the holes but the distance between their bottoms. The upper few feet break out into the

squaring-up holes are placed along the sides, bottom and top, with the ground equally divided between their bottoms. Perhaps two relief holes, one on each side of the cutting-in holes will suffice; C, Fig. 1, shows two on either side and one above, helping the middle back hole, which is important because upon its breaking depends the successful blasting of the other two back holes. In the sketch the cutting-in holes are placed low; they might have been shifted higher and the upper relief holes placed underneath. Quite a common

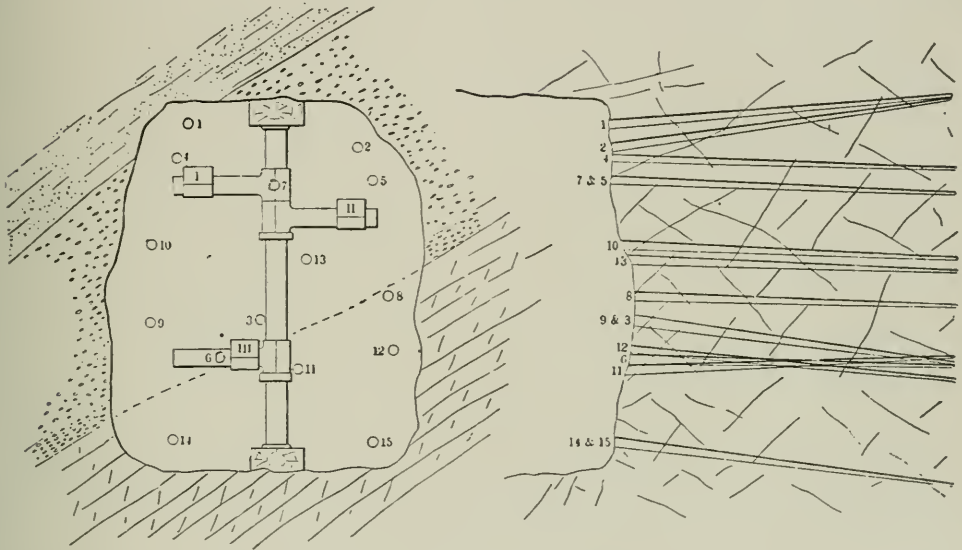


FIG. 2.

drifts comparatively easily, but the inner portion breaks with more difficulty.

In planning the arrangement of holes the first consideration is to get a cutting-in hole that will break well. The smaller the number of holes used for this the better, because it is essential that cutting-in holes be fired simultaneously, and, owing to irregularities in the rate of burning of fuse, this is difficult to accomplish when a large number of holes are to be fired; also, starting a cutting-in hole is often difficult because of the angle at which the drill point has to meet the face. The excavation made by three holes meeting at a point is almost as large as by five or six, so that it is usually better to use only three or four holes for cutting-in; and, if the ground requires them, to put the extra holes in as relief holes where they will break more ground.

After deciding upon the cutting-in, the

alternative is to shift the cutting-in holes to right or left, so that relief holes are required on but one side; thus in D it is seen that the cutting-in holes are to the right and high.

CINDERELLA DEEP.

Fig. 2, from the Cinderella Deep mine in the Transvaal, shows not only the layout of the holes but also the placing of the drills in pushing forward a 7 by 5 ft. drift at a depth of 4,000 feet. The column shown was securely set about 4 ft. from the face and all the holes were drilled by three drills mounted upon the several arms. One arm is rigged to put in a flat hole in the hanging wall, another is fixed directly below this to bore the roof hole on the other side. Safety clamps are used under these two arms and also under the lower one. No. 1 machine drills holes 1, 4, 7, 10; No. 2 drills holes 2, 5, 8, 11, 13; No. 3 drills 3, 6, 9, 12, 14, 15. Though No. 1 has only four holes

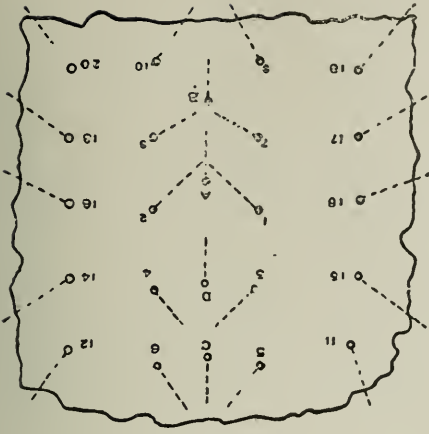


FIG. 4.

looking up but not extending above the top of the tunnel. These were shot together and just after 3 and 4. Cut holes 7 and 8 looked down and were timed to shoot after 5 and 6. The cut lifters 9 and 10 looked down and extended below the proposed bottom of the tunnel. The back rib holes 11 and 12, also rib holes 13 and 14 looked up, while 15 and 16, also 17 and 18 rib holes, and rib lifters 19 and 20 all looked down, all extended beyond the line of the side walls and all were shot at the same time. Where stiff ground was encountered holes A and B were put in and shot with 1 and 2 and with 7 and 8 respective-

ly. Where very stiff ground was found holes C and D were added and shot with holes 3 and 4 and with 5 and 6 respectively.

HOT TIME, NEWHOUSE TUNNEL.

Fig. 5 is from the Hot Time lateral of the Newhouse tunnel, Idaho Springs, Colorado. The bore was $5 \times 7\frac{1}{2}$ ft. in the clear driven through granite, gneiss and schist, very hard to drill and so tough and tenacious that it broke badly. There were, however, no soft seams nor any defined walls to follow, there was no timbering to be done, the ground was not wet enough to require rubber coats, and record progress was made. A horizontal bar was used with a Model 6 Water Leyner drill. The machine man and helper set up the drill without waiting for the dirt from the previous shots to be cleared up. The first set-up of the bar was high enough and far enough from the face to allow holes 1, 2 and 3 to be started close to the back and to be drilled with very little rise in their depth of six feet. From the first set-up of the bar at position A, all the holes except the three bottom ones, or lifters, were drilled. Holes 1, 2, 3, 4, 5 and 6 were drilled with the machine above the bar, to which it was attached directly, without any arm. When these holes were finished the drill was swung under the bar and all the others except the three lifters were drilled. By the time these twelve holes were drilled the muckers had cleaned up the face. Then the bar

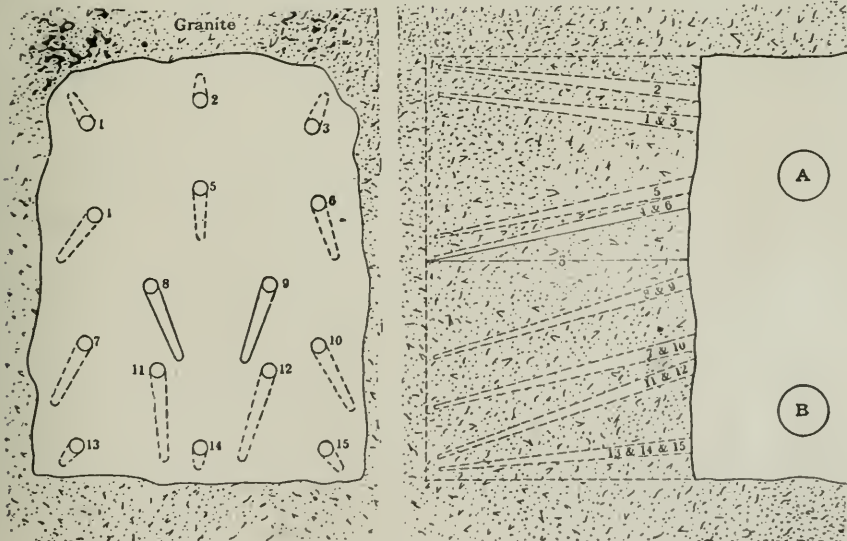


FIG. 5.

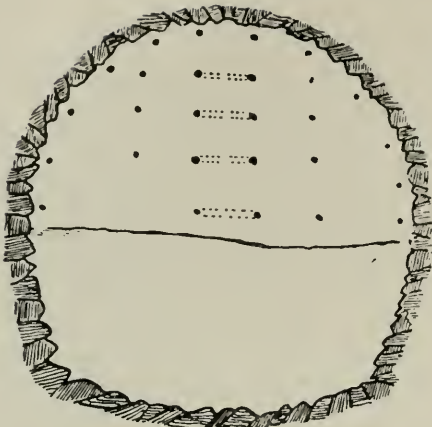


FIG. 6.

was torn down and set up in position B, close to the bottom. The usual round was 15 holes as here shown, each 6 ft. or more deep, bottoming at 1½ in. diameter.

SOUTHWEST LAKE AND LAND TUNNEL.

Fig. 6 is from the Southwest Lake and Land tunnel driven through tough limestone out under the lake at Chicago. The general size of the tunnel is about 16 feet both vertically and horizontally, the heading taking the upper half of the section. Four Ingersoll-Rand drills mounted on two columns were used. There are eight center cut holes with four helpers on each side, while to force the remnant twelve rim holes are drilled around the outside. The bench is removed with eight vertical holes, no lifters being used.

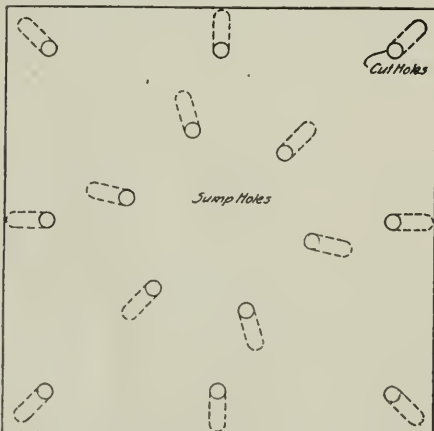


FIG. 7.

NOWATA LEAD AND ZINC COMPANY, SHAFT UPRAISE.

Fig. 7 shows the plan of holes used in up-raising a shaft on the property of the Nowata Lead and Zinc Company, Duenweg, Mo. There was a 6-in. hole from the surface which had been drilled for another purpose and a cable was led down through this from a hoisting engine above, the cable sustaining a platform which carried the drills, the holes, of course, being drilled upward. There were 14 holes driven up 5 feet for each round. Six of these corresponded to the ordinary sump holes when sinking a shaft and the others were the cut holes. When ready to blast the platform was lowered, unhooked from the cable and hauled to one side in the drift of the mine, while the cable was hoisted out of the way.

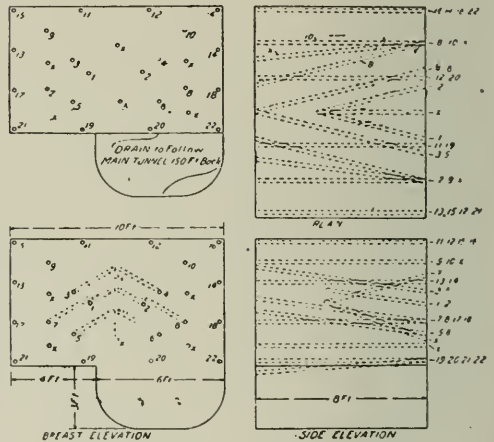


FIG. 8.

ROOSEVELT DRAINAGE TUNNEL.

The Roosevelt drainage tunnel, Cripple Creek, Colorado, is believed to have been about the hardest tunnel driving proposition ever encountered. Three sets of contractors successively undertook the job and failed. The rock is that designated by the government geologists as Pike's Peak granite. Most of it is composed mainly of coarse grains of reddish feldspar, a small amount of quartz, and is usually deficient in hornblend and other dark colored constituents. In some parts the rock has a gneissic or schistose structure, but in the main it is characterized and made notorious by the lack of seams or joints. Thus while the rock itself is hard, the lack of lines

of fracture and planes of seaming is doubtless responsible for the poor rate of progress made by the first contractors. The tunnel was started 10 feet high and 7 feet wide, but in the final contract this was changed to 10 feet wide by 6 feet high over the rails and a 3 by 6 ft. drainage ditch was added.

After the trial of several systems of placing the drill holes, that shown in Fig 8 was finally proved the best adapted to the tough nature of the jointless rock. No. 6 water-Leyner drills were employed, these being later supplanted by No. 9 heavy duty drills. In attacking the ordinary rock all holes were drilled 8 feet, except the cuts and relief cuts, Nos. 1 to 8, inclusive, which were drilled to a 10-foot depth. In extra tough ground, these lengths were each cut down 2 feet and in addition to the 22 holes used on the ordinary rock and numbered in Fig. 8, the six extra holes "X" were put in. In the good breaking ground encountered in the month of January, however, the cut holes were drilled 11 feet, and all others 9 feet deep.

At first, even with the use of from 300 to 350 pounds of 60-per-cent. dynamite, great difficulty was experienced in properly blasting the eight cut holes, sometimes several loadings of them being necessary to blow out the cut. After finally putting in the two extra cuts shown, however, even the toughest ground yielded. The system of placing the holes was

evolved, not only with a view of best blasting the tough rock, but also to allow of the greatest economy of time in drilling. These ends proved to be best effected by mounting the two Leyner drills on a single horizontal cross-bar edged against the sides of the bore, instead of on the usual two independent vertical columns. In this way even the maximum number of 28 holes required but two set-ups of the bar. It will be readily understood that this way of placing the bar eliminates the necessity of mucking out to the bottom before starting drilling, as when vertical columns are used.

The grade line is carried about 18 inches below the top of the bore and about 8 to 12 inches below this is placed the bar. From this, the center and corner back holes are drilled, and then by revolving the drill around and beneath the supporting bar, all of the remaining holes except the center lifters and bottom corners are put in.

It will be understood that the difference in the level of the drill bit between its position on top of the bar, and below the bar, amounts to about 2 feet. By using proper judgment in placing the horizontal bar, therefore, the feat of putting in 18 holes from one set-up is easily accomplished. The cross-bar is then shifted to its second position, usually about 18 to 24 inches above the floor, and the last four holes put in. In tough ground an extra center cut hole "X" is also put in from this set-up.

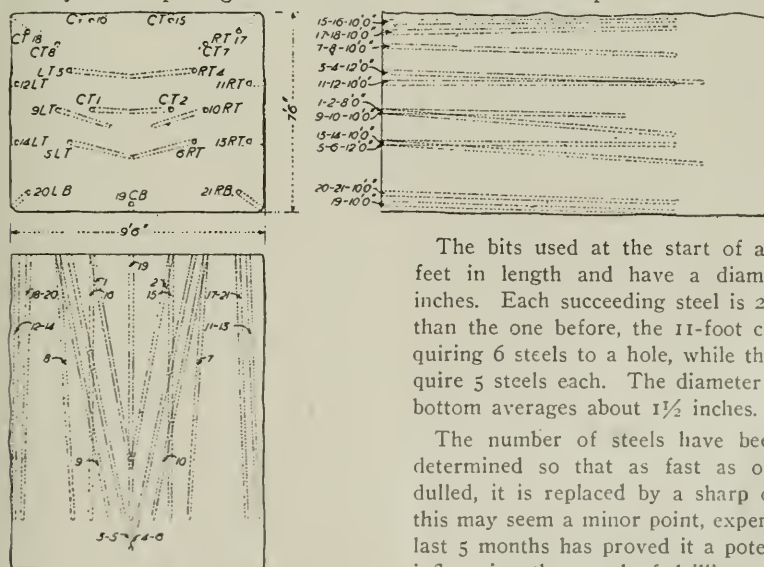


FIG. 9.

The bits used at the start of a hole are 3 feet in length and have a diameter of $2\frac{3}{4}$ inches. Each succeeding steel is 2 feet longer than the one before, the 11-foot cut holes requiring 6 steels to a hole, while the others require 5 steels each. The diameter of the hole bottom averages about $1\frac{1}{2}$ inches.

The number of steels have been carefully determined so that as fast as one becomes dulled, it is replaced by a sharp one. While this may seem a minor point, experience in the last 5 months has proved it a potent factor in influencing the speed of drilling, and increas-

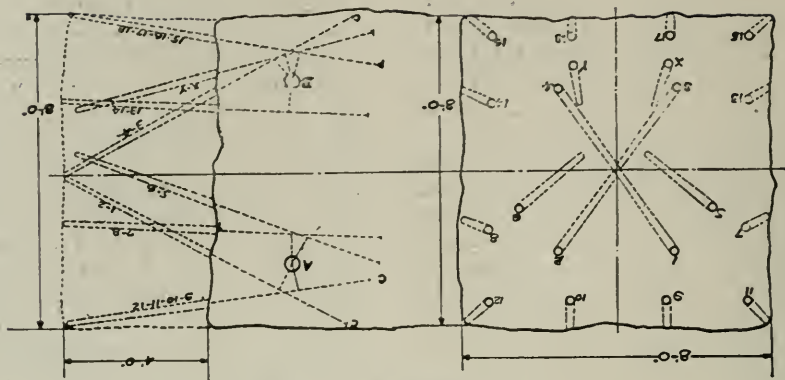


FIG. 10. THE LEYNER CUT.

ing the rate of progress made in driving the tunnel.

The ditch was kept back of the breast about 150 feet and taken out at convenient intervals by placing vertical 3-foot holes spaced on 2-foot centers along the intended center line of the ditch, an ordinary tripod being employed for this work.

LARAMIE-POUDRE TUNNEL.

The Laramie-Poudre tunnel in the beginning of the year 1911 held the two best American tunnel driving records: 609 feet in January, 1911, and 653 feet in March. Fig. 9 shows the layout of the holes in regular work. The holes were drilled and shot in the succession as numbered in the cut, requiring two set-ups of the tunnel bar (no column being used). The upper set-up is drilled on top of the muck pile and in the meantime the muck is cleared away, when the bar is lowered and the lifters put in. Holes are started $2\frac{1}{2}$ inches in diameter and bottomed $1\frac{3}{4}$ inches.

Two No. 8 Water Leyner drills are used drilling 10 ft. and 12 ft. holes. In case of extremely hard rock a third machine was mounted, each machine drilling holes as follows:

Holes lettered LT are drilled by the left-hand machine on the top set-up, those marked CT by the center machine on the top set-up, and those marked RT by right-hand machine on the top set-up. The bar is then lowered and each machine puts in a lifter, lettered, LB, CB, and RB.

The blasting charge for a round generally consists of about 100 sticks of 100 per cent. gelatin, 150 sticks of 60 per cent., and 250 sticks of 50 per cent.

THE LEYNER CUT.

It is proper in this connection to call attention to what has been designated as the "Leyner Cut." This is a systematic arrangement of holes which takes into account the placing of the holes so that they will be most effective in shattering and displacing the rock and also considers the convenience of the driller and the best possibilities of the drill. The objects attained by the use of the Leyner Cut are the drilling of the holes with as few changes of machines and set-ups as possible and pulling first a pyramid shaped wedge of rock from the center, after which the rest of the round breaks readily. It is particularly suitable for solid formations containing no slips or seams to break to and has been used with marked success particularly in the hard bodies of rock and ore in Northern Michigan, resulting in at least one case in drifting at nearly four times the speed made formerly with reciprocating machines. Referring to Fig. 10, C shows where the crank comes back to in each case. A is the cross bar in first position. From the top of the bar the four back holes 9, 10, 11 and 12 are drilled. The machine is then "dumped" or tipped forward until the crank can just turn and clear the back or top of the drift. It is then moved out a little on the bar and the top center cut holes 1 and 2 are drilled. If the bar is set up correctly in a drift of the size here sketched the machine can be "dumped" enough to reach the center of the drift heading with the bottom of the hole. The machines are then turned under the bar and side holes 7 and 8 and cut holes 5 and 6 are drilled. The bar is then changed to position B, the machines are set up on top and

side holes 13 and 14 are drilled. Then after turning the machines under the bar, they are tipped up in front so that the crank just clears the bottom of the drift and holes 3 and 4 are drilled to about meet holes 1 and 2 in the center of the heading. The four lifters 15, 16, 17 and 18 are then drilled and if there is time enough relievers, as X and Y, may be drilled to make sure, but if sufficiently strong explosive is used the round will break without them. This round has increased the amount of development work accomplished wherever it has been used, and there are two reasons why it is practically impossible with piston drills. They are unable to drill fast enough, particularly on account of the dry holes, and the size of the piston drill is too great to permit the putting of it in the positions necessary to give the holes the proper pitch and angle.

DRIVING A LONG ADIT AT BONANZA COLO.

BY WILL C. RUSSELL.*

The Rawley Mining Co., operating at Bonanza, Saguache County, Colo., has completed its new 6,235-ft. development and drainage tunnel, having cut the main lode 1,200 ft. from the surface and at a point 600 ft. perpendicularly below the lowest former workings, exposing a 6-ft. vein of heavy iron-sulphide ore, carrying silver and copper, together with a small percentage of lead and zinc and a little gold.

UNDERGROUND CONDITIONS.

The work of driving this tunnel, which is 7x8 ft. in the clear, running principally through altered andesite and at about a right angle to the vein system, covered a period of 17 months and 12 days. The rock varied greatly in hardness and friability, it having been necessary to timber a total of 1,618 ft. As an indication of the irregularity of the formation, it may be said that in April, 1912, only 40 ft., were driven, while in August, 1912, the adit was advanced 555 ft. in 26 days of drilling, the remainder of the month having been given up to timbering.

Considerable water was encountered at various points, a maximum flow of 1,500 gal. per min. having been struck in December, 1911, which finally decreased to about 1,000 gal. per min., which latter amount is now issuing from the portal. One of the chief reasons for

running the tunnel was the draining of the upper workings of the company, which have a total length of 7,416 ft., and about one-half of which are in commercial ore. Upon cutting the vein at the 1,200-ft. level, the upper workings began to drain at once, and in 38 days thereafter they were completely unwatered.

The tapping of the vein at the tunnel level immediately put in sight an additional, large tonnage of ore, the shoot on the third level, where the greatest amount of drifting has been done, being 840 ft. in length. No ore has been stoped or shipped from the mine for seven years, it having been the policy of the company to develop a tonnage of sufficient magnitude to justify handling the property on a large scale. From the surface to the 1,200-ft. level, the ore has changed considerably in character, i. e., from a silver-lead-zinc ore above, to a silver-copper ore below. Certain portions of the ore can be shipped as mined, others may be sorted and shipped, while still others should be milled. The company has on the property a 100-ton concentrating mill, which was erected for experimental purposes.

EQUIPMENT USED.

In the work of constructing the new tunnel, there were consumed 41 tons of 16-lb. rails, 38 tons 241 lb. of powder, 33,819 caps, 51 miles of fuse, and a little over 2,000 cords of wood. A steam plant of 120 hp. capacity and an Imperial type 10 Rand compressor furnished the power, while the workings were ventilated by a No. 3 Roots suction blower, directly connected with a 9x9-in. high-speed, upright engine.

Slip-joint pipe, 12 and 13 in. in diameter, of No. 18 iron, riveted and dipped, was used in connection with the blower, while the compressed-air pipe ran from a maximum of 6 in. down to 3 in. in diameter at the heading. Three air receivers, 42 in. in diameter by 10 ft. in length, were placed at intervals of about 2,000 ft. in the tunnel. In the blacksmith shop there were used a No. 8 Bradley coke furnace for heating the drill steel and a No. 2 Leyner pneumatic sharpener, drop hammer, etc. For the purposes of the tunnel construction alone a camp of 14 buildings was erected. A total of 40 all-steel cars of 17½ cu. ft. capacity each, and six animals were used for hauling the muck. The normal crew in the heading consisted of a shift boss, two machine men, two machine helpers, three muckers, two trammers and a pipe-and-track man.

*Manager, Rawley Mining Co., Bonanza, Colo.

ROUTINE OF WORK.

Two machine drills of the No. 8 water Leyner type, carrying 1¼-in. hollow steel, were used on each shift and were mounted on a 7-ft. cross-bar for the top set-up and on an 8-ft. bar for the bottom set-up. Three hangers set into hitches in the ribs at the roof, held the air and water hose in the clear. No. 44 square-pointed shovels were used to remove the muck from heavy steel plates, which covered the floor from rib to rib and extended 30 ft. from the face.

At the beginning of the operation two shifts, drilling 7- and 8-ft. rounds were maintained, but later on it was found that three shifts drilling shorter rounds produced better average results. During the operation of removing the muck, the machine men drilled the top, and in ordinary ground the muck was removed by the time the machine men were ready for the lifters. According to the requirements of the ground, 8x8-in. and 10x12-in. timbers were installed, mud sills being laid wherever full tunnel sets became necessary. Most of the timbers were peeled and hewed, these being considered superior to sawed material.

A ditch 1 ft. in depth and 2 ft. in width, dug along the right rib and under the mud sills, carried off the water. The ventilation, compressed-air and machine-water pipes were set on cross ties over the ditch, while the track was placed on the opposite side of the tunnel. A grade of 6 in. to 100 ft. was adopted, all the timbers being lined and graded with instruments.

In the operation of driving, hangers suspended from plugs in the roof were used to give the center line, and the grade of the back. At every survey station the grade was taken and corrected, and upon completion of the 6,235 ft. a check leveling showed the breast to be a little over a foot above schedule, this rise having been due to the difficulty in laying sills in flooded and running ground. After considerable experimenting it was found that 40 per cent. dynamite was the most efficient explosive day in and day out. The entire cost of the adit was \$123,920, or \$19.87 per ft. During the operation, John Allen Davis, engineer of the U. S. Bureau of Mines, spent 10 days on the property gathering data which is to be published in one of the forthcoming Government reports.

Messrs. Simonds & Burns, of New York, consulting engineers of the Rawley company, planned the work, while the local operators were in charge of Will C. Russell, manager, and Charles E. Beckwith, engineer.—*Engineering and Mining Journal*.

SHALLOW HOLES VERSUS DEEP HOLES

The driving of the Rawley tunnel, treated of in the preceding article, was described in greater detail in a paper by Mr. F. M. Simonds and Mr. E. Z. Burns presented at the New York meeting of the American Institute of Mining Engineers. The following is, in part, the contribution to the discussion of this paper by Mr. W. L. Saunders:

The dimensions of this tunnel are 7 feet high by 8 feet wide with a length of a little over 6,000 feet, a typical mining tunnel, a little over one mile long, and of familiar dimensions. The best monthly progress, 8 to 12 ft. rounds, is 414 feet, and the best monthly progress for the shallow rounds 4½ to 5½ feet amounted to 555 feet. I want to call particular attention to the statement that when they changed from a double shift to a triple shift, putting in shallow holes, that they got better progress. The shallow hole idea is the European idea, it is the Alpine Tunnel idea, it is the idea by which engineers have carried through those great enterprises of piercing the Alps, in the case of the Simplon Tunnel and the Arlberg and the Loetschberg Tunnel. These recent Alpine tunnels have all been driven on the shallow hole plan, in other words, they put in a hole about a meter or a little more than a meter in depth, and of rather large diameter, as compared with the American system, which is a hole as large as you can reasonably get it; and that means that by the time it is in to the bottom, say 10, 12 or 14 feet, it is just a little larger than the diameter of the steel, the result being that you are putting the explosive at the bottom in a section of hole of small diameter, which is the very reverse of what is wanted to produce the most effective results. It is much better—and this is a point I have emphasized before the Institute in papers in the past years—to put in a large number of shallow holes of large diameter and use a great deal of powder than to put in a small

number of deep holes and try to save powder and try to be very particular about the exact direction that the hole must take. The European system simply peppers the head with holes, and they get better results by doing it.

The total cost per foot of advance in completed tunnel is \$19.87. That is a very fair figure, and less than the estimated cost made before this tunnel was driven. The average total cost per cubic yard excavated is \$7.64. That may seem high to some of us, but if you go over the figures of labor cost in this paper you will see that the wages are higher. The people employed on this work have evidently been compelled to pay a maximum rate of wages for this class of work, and taking that into consideration the figures are not high. The average number of feet of hole per drill per drill hour was 12.2. The approximate yardage per foot of advance, allowing for 25 per cent. over-breakage and swelling, was 2.6 yards, or a cost of \$7.64 per cubic yard. In all of this we must take into consideration the difficult rock which was encountered and the water troubles which they had; yet, to compare the progress of this tunnel with that of any of the recent tunnel records which we have, the progress appears to be very favorable.

The most recent of these figures was made at the Arizona Copper Company's mines at Morenci, Arizona, the tunnel being 8 by 9 feet, where 780 feet advance was made in twenty-nine days, employing two C-110 drills mounted upon a cross-bar. We also have the record of the Laramie Tunnel, in Colorado, which was similar to this except that it had a ragged section, which fact enabled them to make greater progress. In the Laramie Tunnel the progress was in excess of the progress given in this paper.

Now, the description of the process of driving tells us that this tunnel was driven by the system of mounting a horizontal cross-bar across the tunnel. Here we have a thoroughly modern system, the same, by the way, as was used at the Laramie Tunnel. In the American system of tunnel driving vertical columns with arms on them are usually employed. The European system employs horizontal bars mounted on carriages. The system described in this paper is neither one nor the other; they use a horizontal bar without any carriage; in other words, they have adopted the Alpine system of tunnel driving, but they do away

with the carriage. The piston drill is a machine which reciprocates and which creates a great deal of shock on its mounting, necessitating a very heavy bar or column. The machine itself is heavy, and using it in that way they must either adopt the carriage system or the vertical column with arms.

Those who drove this tunnel used the hammer drill, which is lighter in weight and does not give the jarring and reciprocation, hence they are able to use a light bar which a few men in the heading can handle to advantage. This light bar is carried on top of the muck pile after the blast and jacked in place at a distance close to the roof, the drills are put on and put in operation, the men work the drills standing on top of the muck, the muckers being at work at the same time in digging away the muck underneath them. By the time they get this muck removed to a considerable extent the drillers are about ready to let the bar down, and just about that time the muck has been taken away, so that if necessary it can be placed at a lower position in order to put in the lower round of holes if these cannot be drilled from a single setting of the cross-bar. By such a system as this they have been able to make a progress, I believe, of twenty-six feet per day, in other words, a little more than one foot an hour during all of the twenty-four hours in the day. That, of course, is not the record. The Alpine system has made about 30 feet per day, and in the Laramie Tunnel they have made something like 24 feet a day. Comparing progress of this character, however, we must always take the rock into consideration, also the length of the tunnel. The Alpine tunnels are longer tunnels, and they were able, by adopting a certain system and carrying it out for a long period of time, to get the efficiency of the workers very high.

The engineers in this tunnel decided that better results could be obtained by operating three shifts per day to drill shallow holes. This plan was put into effect December, 1911, and it proved to be very efficient. In calculating the results as given in the table printed in the paper, it shows that the average number of feet of hole per drill per drilling hour was 12.2 feet. This is good, but not remarkable, as it involves only approximately 2.5 inches per minute. Of course, the rock conditions govern this.

COMPRESSED AIR TROUBLE IN AN ENGLISH MINE

BY FRANK RICHARDS.

I wish to call the reader's attention to the essential portions of an interesting letter recently received from the manager of a large English coal mine. The writer says:

"We have at this colliery a large compressed-air installation. The compressor consists of a cross-compound condensing steam engine and a two-stage air compressor with a capacity of 9,000 cu. ft. of free air per minute. We have about 13 miles of pipe, which comprises two mains, each 4 miles long; two mains, each 2 miles long; and various lengths of tapings, making a total of about 13 miles.

"The air pressure, at the compressor, situated on the surface, is 52 lb. gage, while at the two ends of the 4-mile mains (especially in the winter time, or in cold weather), the pressure varies from 10 to 14 lb. gage, which shows a loss of from 73 to 80 per cent. As the entire colliery depends on compressed air for driving the hauling engines and pumps (not coal cutters), this great loss is an important item. If you can suggest a way to reduce this loss of power it will be welcome information.

"The shaft is 1,600 ft. deep. Would covering the pipes leading down the shaft, with some nonconducting material, such as boiler covering, be of any use? The temperature of the air leaving the compressor is 250 deg. and at the shaft bottom it is only 90 deg. F."

In answer to the question asked in this letter, allow me to say nothing could be gained by covering the pipes. When air is transmitted to such distances, it invariably attains, more or less closely, the temperature of the surroundings. This is quite plainly the case here where the temperature of the air, in going only a third of a mile or so down the shaft, has fallen 160 deg. F.

It would seem, at once, that this is a case of too low initial pressure, very common in English mining practice, and an insufficient pipe capacity. It is much to be regretted that no information is given regarding the size of the pipes, which is a most important particular.

In the absence of any statement to the contrary, we may assume, at first, that the pipes are without leakage, which may or may not be the case. Air pipes with proper attention are less likely to leak than steam pipes; but

often they do leak more, because the air leak does not sizzle and drip and compel attention, as do steam leaks. That air-pipe lines may be made tight is attested by the many long pipe lines in use and kept at full pressure in switch and signal service; and by the many-jointed and valved air-brake pipes, in service on trains.

We would, in the present case, shut off everything, at the extremities of the lines or wherever the air is used; and pump up to maximum pressure, at the compressor; and observe how this pressure holds. If the pressure continuously drops there are, of course, leaks and these must be found and stopped. If the pipe is properly laid at first, there should be no leaks and none are likely to develop later. But leaks, however, small, will grow bigger and become more and more difficult to stop. It is unfortunate for anyone who has to do with compressed air to assume that leaks are a legitimate part of the game. On the contrary, they show a poor installation.

PIPE CAPACITIES.

The Johnson formula for the flow of air in pipes, which is quite generally used, is with a slight change of the constant, as follows:

$$p_1^2 - p_2^2 = \frac{V^2 l}{2000 d^5} \quad (A)$$

Here, V is the volume of free air, in cubic feet per minute; l is the length of pipe, in feet; d the diameter of the pipe, in inches; p_1 the initial absolute pressure (gage pressure + 14.7, for sea level); and p_2 terminal absolute pressure.

The formula (A) may be transformed as follows, according to the purpose for which it may be used:

$$l = \frac{2000 d^5 (p_1^2 - p_2^2)}{V^2} \quad (B)$$

$$V = \sqrt{\frac{2000 d^5 (p_1^2 - p_2^2)}{l}} \quad (C)$$

$$d = \sqrt[5]{\frac{V^2 l}{2000 (p_1^2 - p_2^2)}} \quad (D)$$

In the case before us, the absolute pressure, at the compressor, is $52 + 14.7 = 66.7$ lb. per sq. in.; and the pressure at the end is, say $14 + 14.7 = 28.7$ lb. per sq. in., the difference or drop being $66.7 - 28.7 = 38$ lb. This terminal pressure, by the way, is 43 per cent. of the initial pressure, and the percentage of pres-

sure "loss" is only 57, instead of 80 per cent., as stated.

We are told that there are two 4-mile lines; and we may assume that each transmits about one-half of the air, so as to enable us to estimate the possible conditions. Say, then, that we have a 9-in. pipe (which we are aware is not a common commercial size), 4 miles long, transmitting, say 4,500 cu. ft. of free air per minute, at the initial pressure of 66.7 lb. absolute.

By formula A , we have,

$$p_1^2 - p_2^2 = \frac{4500^2 \times 4 \times 5280}{2000 \times 9^5} = 3621$$

which gives the difference between the squares of the initial and terminal absolute pressures. But, $66.7^2 = 4449$, and $4449 - 3621 = 828$; and $\sqrt{828} = 28.7$, which is, therefore, the terminal absolute pressure. This shows a drop of $66.7 - 28.7 = 38$ lb.

Noting the above result, obtained from formula A , taking the initial pressure at 52 lb. gage; let us now assume that the initial pressure was, say 100 lb. gage, or $100 + 14.7 = 114.7$ absolute; and observe the difference. Now, since $114.7^2 = 13,156$, we have $13,156 - 3621 = 9535$; and $\sqrt{9535} = 97.65$, which is then the terminal absolute pressure. The pressure drop in this case is $114.7 - 97.65 = 17$ lb.

This shows clearly what an increase of initial pressure will do toward reducing the pressure drop, in transmission. Without giving further figures, it may be stated that if, in the last case, the pipe had been 10 instead of 9 in. in diameter, the theoretical terminal absolute pressure would have been 105 instead of 97.65 lb., and the drop would then be only $114.7 - 105 = 9.7$ lb. Thus, by adopting a suitable diameter of pipe the pressure drop, in transmission, may be whatever we choose.

RELATIVE CAPACITIES OF SMALL PIPES

In many installations where the *mains* are of sufficient size, there is still a considerable final drop of pressure in branches and extensions that are too small. It is not sufficient to have the sum of the sectional areas of the smaller pipes equal to that of the main pipe that supplies them. The pipe areas are, of course, directly as the squares of the diameters. For example, a 2-in. pipe has one-fourth the area of a 4-in. pipe; but, for the same pressure drop, four 2-in. pipes, though having the same total area, will transmit much

less air than the single 4-in. pipe, because of the greater rubbing surface of the former. If the four 2-in. pipes were required to transmit the same quantity of air, per unit of time, the pressure drop would have to be much greater.

It has been found, in practice, that the square root of the fifth power of the diameter approximates the relation of pipe capacities for delivering air. For example, as stated previously, a pipe of one-half the diameter of another has only one-fourth the area of the larger pipe; but it will not transmit one-fourth as much air, under the same pressure drop. For the same pressure drop, the ratio of air volume, in this case, will be

$$\frac{V_1}{V_2} = \frac{\sqrt{\left(\frac{1}{2}\right)^5}}{\sqrt{\left(\frac{1}{32}\right)^5}} = \sqrt{\frac{1}{32}} = \sqrt{0.03125} = 0.176$$

Then, to transmit the same volume of free air, under the same drop of pressure, will require

$$\frac{1}{0.176} = 5.65 \text{ of the smaller pipes. Or, say a } 0.176$$

pipe of twice the diameter of another will transmit 5.65 times the volume of air, with the same pressure drop, for any given distance and initial pressure. This difference becomes greater as the difference in pipe diameters increase. A pipe of only one-fourth the diameter of another will transmit not $\frac{1}{16}$,

but $\sqrt{\left(\frac{1}{4}\right)^5} = \frac{1}{32}$ of the air volume, for the same initial pressure, pressure drop and distance.

AIR SAVED BY PRESSURE LOSS.

It must not be supposed, however, that this drop of pressure, in transmission, always, means a loss of power. That will depend on the way in which the air is used in doing its work, after transmission. There might be cases where the pressure drop outlined in the above, letter would mean a gain in actual power or a saving in air consumption, rather than the reverse; and, in that case, the loss of pressure mentioned might prove to be the most economical feature of the proposition.

The wasteful habit of the ordinary steam pump when driven by compressed air is notorious. Not only is the air used without cutoff or expansion while doing its work, and there are excessive clearances to fill; but, at the end of the stroke, the entire cylinder will fill with air at a pressure perhaps considerably

above the required working pressure, equalizing the pressure in the pipe line. The greater this excess of pipe pressure, therefore, over that required for the pump, the greater will be the loss of air.

It is always desirable to transmit air at high pressures, for the sake of pipe-line cost, if long distances are to be traversed. While the air is at a high pressure, the opportunity is presented for draining the air, so that the later freezing of exhausts may be minimized. If the air is to be used at high pressure, as usually it should be, it ought to be used expansively and reheated, if possible. The various types of rock drills now in use call for pressures approximating 100 lb. gage, in order to develop the highest efficiency in the drills.

The indications are that, in the above colliery, the pumps and the haulage apparatus mentioned would be amply supplied, so far as pressure is concerned, if a 20-lb. pressure could be maintained. If the air were to be used at that pressure but reached the work, at a pressure considerably higher; pressure reducers should be employed at that point; and after reducing the pressure, the air should be reheated as near to the work as possible. In this case, the pipe line mentioned serves as a pressure reducer; but it seems to overdo the business. It is also, to a certain extent, a reheater; as the air, notwithstanding the drop in pressure, will generally reach the point where the work is to be performed, at a temperature close to that of its surroundings.

We may say that the case in hand is a bad one and cannot be improved without redesigning and reconstructing the entire system, the cost of which would probably be prohibitive. Leaks should be sought and stopped. With two-stage compression, the delivery pressure should approximate 100 lb. gage, or, say, at least, not less than 80 lb. gage. In the present case, however, this would prove of little advantage, unless arrangements were made to use the air economically. It seems quite evident that the "loss" of pressure, in transmission, in this colliery, is only an item that is by no means the chief element of inefficiency. —*Coal Age.*

THE NEW YORK WATER TUBE

BY S. W. SYMONS.

Few New Yorkers realize the magnitude of the engineering operations continually in progress within the city limits. None of them who are not in touch with the work can tell you for instance what is being done on the immense system of subways now under way in New York, and the greatest undertaking of all, the Catskill Aqueduct, which ranks in magnitude with the Panama Canal, is still less known and talked about, though indications of the work can scarcely be avoided. There are noises heard and movements felt throughout the city causing disturbance in the minds of nervous citizens, caused by the tunnel men blasting their way through the solid rock of Manhattan, three hundred feet and more below the surface.

Shaft No. 6, which is being driven by the Pittsburgh Contracting Co., is located on the southeast corner of Aqueduct and Tremont avenues, the Bronx. Ground was broken in August, 1911, electric drills beginning the job of sinking the shaft, which is 300 feet deep. Several makes of such drills were tried, but none were satisfactory, and it was found necessary to enlist the aid of several air hammer or "Jap" drills to complete the shaft without unreasonable delay, a small belt driven compressor being installed to operate them. When tunneling operations were started, in both directions from the shaft, the electric drills were abandoned and a compressing plant, consisting of two Imperial belt driven compressors of 1051 and 534 cu. ft. capacity, respectively driven by two General Electric motors, was installed, together with several "Sergeant" Rock Drills.

When only one heading is being drilled the smaller machine is shut down, when both headings are being drilled the larger machine is run continuously and the smaller is set to compensate for the fluctuations. An air receiver is placed in a horizontal position outside the compressor room, from there the air is taken to the bottom of the shaft in a 6 inch pipe, reduced to a 4 inch pipe running north and south to the two headings. 100 lbs. pressure is carried at the receiver, giving about 93 lb. at the drill manifold.

To the right of the compressing plant is the blacksmith shop equipped with two coal forges. One smith and two assistants are kept busy sharpening drill steels. Close by is a

Sand for concrete is being shipped from Seattle, Washington, to Honolulu, Hawaiian Islands, as there is no suitable sand on the islands, which are of volcanic origin and surrounded by coral reefs.

General Electric mine hoist for hoisting the cage. Directly above the compressor plant is the shaft head, office and storeroom; from the shaft head about 100 yards of track lead across Tremont avenue to a vacant lot where a small crushing plant is erected; there the spoil is crushed and stored for future use in the concrete lining of the tunnel.

TUNNEL DRIVING METHODS

The tunnel or rather tunnels are driven on the heading and bench method; the heading, which takes up one-half of the tunnel section, being kept about 10 feet in advance. The tunnel is circular in section, roughly 18 feet in diameter, necessitating the removal of 9.42 cu. yds. of spoil for every foot of advance, or approximately 70 cu. yds. for every day's advance (7.5 ft.). This would be considerably more when considered in terms of loose material; probably 90 or 100 cu. yards.

The finished Water Tube will be lined with concrete to a thickness of one and one-half feet, reducing the diameter to 15 ft. The headings run approximately northeast and southwest, the north heading at the writer's visit was 1025 ft. and the south heading 1100 ft. from the shaft; they are expected to meet the headings from shafts 5 and 7 some time in August.

Fig 1 is a diagram of the breast, showing how the holes are placed and fired.

Fig. 2 shows the heading, which takes up approximately one-half of the completed tunnel; it will be noticed that six drills are used, mounted on three columns, two arms and two drills to each column, holes No. 1-2-3-4-11-12-13 (see diagram) are drilled from the left hand column; No. 5-14-15-16-6-17-18-19 from the center column; No. 20-21-22-7-8-9-10 from the right hand column. The lower arms are then swung around and the drills turned down for the bench holes, all holes being drilled without changing the set-up of the columns. All holes are started at 3 inches and bottomed at $2\frac{3}{4}$ inches, Rose and Cross bits on $1\frac{1}{4}$ and $1\frac{1}{2}$ hexagon steel being used.

Drilling is started about 4 P. M. and the round is completed in one shift. Blasting is carried on from 4 A. M. to about 7, holes being shot by electricity; 700 to 800 lbs. of powder is used per day for both headings, side and bench holes are loaded with 10 to 12 lbs. and cut holes with 9 to 10 lbs. The short cut holes and the bench are shot first, the long

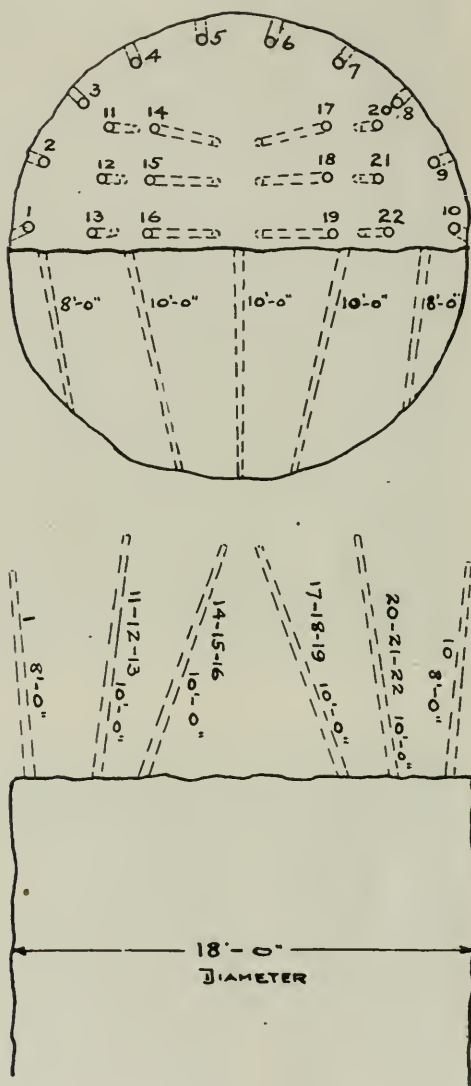


FIG. 1.

cut second and the back and side holes last. The heading has been advanced steadily at an average of $7\frac{1}{2}$ ft. per day.

A saving is made in the high priced drill runners' time by having the mucking crew set up the drills, ready for the next round, as soon as they have cleared away the breast. This means that the drill runners can begin work without delay, everything being ready for them by 4 P. M.

In the north heading some soft material was encountered and temporary steel mine props



FIG. 2. WORK IN THE HEADING.



FIG. 3. BELT DRIVEN COMPRESSOR—WITHOUT THE BELT.

were resorted to, these had to be placed so close to the face that they suffered severely from the blast every time the face was shot, and considerable time was lost straightening the bent and twisted props before regular work could be resumed.

The drill crew, for each heading, consists of 6 drill runners, 6 helpers and a water boy.

MUCKING.

A double track is laid from the shaft to within a short distance of the breast, while a single overhead trolley wire supplies current for a small electric mine locomotive. From the end of the permanent track to the breast, rails are laid on one side and the flanges of the truck wheels run in the channel section, the locomotive taking its power through a length of wire connected at one end to the overhead system, the other end being wound and unwound on a winch attached to the locomotive.

As soon as the foul gases have been sufficiently dispersed, air being blown in from a fan through a conduit reaching nearly to the face, the mucking gang start work, clearing away the breast. An overhead system of planks is laid from the bench to the end of the car tracks, supported on bars set between the sides of the tunnel and of a sufficient height to allow the mine trucks to pass underneath. Two mine trucks are run as close to the breast as the muck will allow, part of the mucking gang work on the floor of the tunnel, shoveling into the nearest truck and working towards the breast, the rest work on top of the muck, shoveling into the nearest truck and working towards the breast, the rest work on top of the muck, shoveling into barrows on the overhead system and working away from the breast, the barrows, of which there are two kept going, are emptied into the farthest mine truck.

Owing to the large cross section of the tunnel, necessitating the removal of a correspondingly large amount of spoil each shift, mucking is practically carried on continuously.

EQUIPMENT.

In the several contracts of the New York section compressed air is supplied mostly by electrically driven compressors, either belted or direct connected. The compressors at this shaft are of the "Imperial" Type with an aggregate capacity sufficient to run 8 out of the 12 piston drills used, the work in the head-

ings being arranged accordingly. They are "long belted" to GE motors of 100 and 200 H. P.

These particular machines have not had a cent of repairs on them since they were purchased by the Pittsburgh Contracting Co., two and one-half years ago. In some of the later installations greater economy has been gained by the use of direct connected electric driven air compressors, of these there are ten Ingersoll-Rand Class PE-2 and 3 Sullivan direct connected machines; using motors of the engine type as manufactured by the General Electric Co., Crocker Wheeler and Westinghouse Mfg. Co.

Though the first cost of direct connected units is necessarily higher, the saving realized, even in installations of a semi-permanent character such as these, is so marked, that first cost, so long as it is commercial, can be regarded as a minor consideration.

Of the Rock Drills used the "Sergeant" type seems to be the favorite, 3¼ and 3½ inch machines being most generally used.

One of the drills used in shaft No. 6 is a small light machine of a comparatively new design—called the "Improved Sergeant." It is a very hard, fast hitter and seems to easily hold its own against its larger contemporaries.

Trimming is mostly done with a "Bull Moose" or rotating "Jap" drill, or a Jack-hammer, the automatic rotating features of these drills greatly facilitating the work.

Several Triplex pumps are used for unwatering the various shafts and in shaft No. 6 a small direct acting air operated pump was placed about half way to the heading. The pumps were not in operation during the writer's visit, very little water being present. Altogether the work is progressing very well, considering the size of the tunnel and the hardness of the rock. The methods might be said to be typical for the greater part of the Aqueduct, varying mostly in minor details. It is of course impossible to list all of the equipment used, since this is of such a varying character, though the two most important items entering into tunnel driving, the compressors and rock drills seem to be fairly well standardized.

A new heat indicator is a bright red paint which turns almost black before reaching the boiling point and resumes its normal color when it cools again.

The Mine Mule

BY BERTON BRALEY

He sees the pleasant daylight only once or twice a year,
When they take him out to gambol on the grass;
But he cocks those funny eyes of his and waves a crazy ear,
And you bet he's wise to all that comes to pass.
He is meaner than the skinner—and the skinner's awful mean—
But he's stronger than the cable on the cage;
And of all the critters underground it's plainly to be seen
That the mule's the boy who always earns his wage!

The skinner is a driver who swears a purple streak,
But profanity is love talk to the mule;
He would kick the gentle miner to the middle of next week,
But when the skinner beats him he is cool.
For the mule he loves the skinner, and the skinner loves him back,
Though you sure would never know it by his talk;
And the mule he hauls a string of cars along the bumpy track
And very, very seldom will he balk.

But if the mule gets sulky he can tangle up the mine,
While the pit boss and the cager stand and swear;
And the cars are backed behind him in a long, unbroken line
And the skinner hops around and tears his hair.
Yet when the mule is ready he will start to work again,
And merrily he hauls the cars away;
For like that guy, Sir Galahad, he has the strength of ten
When he really wants to bring it into play.

So, here's to Mr. Long Ears with the tassel on his tail,
May he prosper like a dividend that's fat;
And when he's done with working and he hits the spirit trail,
May he go where all the saintly mules are at!
Where there isn't any mining and there isn't any coal,
And a skinner is a critter never met;
Where the only occupation is to bray with all his soul
For the mule has earned his Heaven, you can bet!

—*Coal Age.*

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

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[In the March issue of COMPRESSED AIR MAGAZINE, page 6733, the first four lines at the top of the first column belong at the bottom of the second column.]

THE YOUNGER GENERATION OF ROCK DRILLS

One of the handiest additions to the rock drill complement in recent years, has been the perfected hand-hammer drill known in various mining sections by different terms of endearment, such as "Plugger Drill;" "Jap Drill;" "Jackhammer," etc.

It has come to be recognized as the "Handy Andy" of them all.

This little drill in addition to many well known applications, such as pop-shooting, plug and feather work in quarries, breaking up boulders and taking out ledges of rock in road construction, trimming walls and cutting hitches in mines and tunnels, as well as shaft sinking, etc., has recently been applied to the removal of old foundations of various descriptions in the building field as well as machinery foundations.

Every large industrial plant has at some time or other been confronted by the problem of growth necessitating building enlargements or the replacement of obsolete or inadequate machine tools by more modern equipment calling for new and heavier foundations and therefore the alteration or removal of the old.

Heretofore it has been the custom to remove these foundations (which in the majority of cases are of solid concrete) by hand; a slow, laborious and expensive process. Concrete itself, being composed of a number of constituents, presents great difficulties in drilling to the ordinary hand rotated machine drill, various experiments in the past having always resulted in a return to hand methods.

Quite recently the Philadelphia Electric Co., of Philadelphia, had in one of their local power stations a large machine foundation which they were obliged to remove in order to install a machine of another character from that previously occupying the space. This foundation was surrounded on all sides by expensive and delicate machines, necessitating a careful selection of the method and means for doing the work. A test was therefore made of several devices which could be applied, resulting in the adoption of an auto-

matically rotated "Plugger" or "Jackhammer" drill for this work.

There is a certain percentage of moisture present in concrete, which seems to cause the dust to pack and form a mud collar above the bit making it necessary, where hand rotated tools are employed, to withdraw the steel by means of a wrench, which operation is generally attended by considerable labor and difficulty; whereas with the automatically rotating type no difficulty is experienced from these mud collars.

A steel holding device attached to the tool made it possible to agitate the mud, further a throttle placed in the exhaust elbow made it possible to throttle the exhaust and force it through the hollow drill steel to the bottom of the drill hole, effectually removing the dust and mud. In a test run it was found that a progress of 24 inches could be made in 1 minute and 12 seconds as compared to 18 inches in 5½ minutes with the hand rotated type.

DEEP MINING

The Witwatersrand is now mining ore at a depth of over 5,000 ft. The South African Mining Journal says the probabilities are that in the not distant future Rand ore will be worked at a depth of a mile and a half and even more, there being no mechanical barriers to prevent it. For the present, however, the greatest depth to which man has penetrated on the Rand is 5,040 feet, which is the vertical depth at the bottom of the inclined portion in the Catlin shaft of the Jupiter Gold Mining Company. The depth of the vertical portion of this shaft is 4,243 feet. The second deepest shaft on the Witwatersrand is the Turf Mines shaft of the Village Deep Company, which has been sunk to 4,144 feet. The vertical depth at the bottom of the inclined portion of this shaft is 4,184 feet. It can safely be asserted that no other metalliferous formation in the world has been found to extend over such a large area and to such a great depth as the Main Reef series, and the statistics, considering the small and uniform increase in temperature noted in these deep workings, must make one very hopeful as to the possibilities of mining at a profit 8,000 feet below the surface. Two other gold mines have probed the earth to a depth as great if not greater than the Rand properties. These

are the St. John del Rey, in Brazil, and the New Chum Railway Mine, in Victoria. The greatest depths of all at which metalliferous mining is being carried on at the present time are in the Michigan copper belt, where they work at a vertical depth of between 5,000 and 6,000 feet. The deepest collieries are in Belgium and Germany, where, we believe, colliers are at work at depths of a mile and a quarter from the surface.

NECESSITY OF TRAINING FOR MINE RESCUERS

There is some difference of opinion among persons who have worn breathing apparatus in actual mine-rescue work as to the length of time a man should be required to receive training with the apparatus before he is considered as qualified to engage in mine-rescue or recovery work. All, however, admit that it is necessary for a man to take regular training at stated intervals in order to keep in proper condition for wearing the apparatus in cases of emergency. Whether the duration of the intervals be two weeks or three months, some system of regular practice should be adopted. The Bureau of Mines requires each of the miners it employs at its mine-safety cars and stations to take two hours' practice in vitiated air once each week. At mining camps or mines where rescue stations are established, the regular mine-rescue corps should be required, after completing their preliminary training, to undergo practice at frequent intervals. In localities where rescue stations and apparatus are not available, it is, of course, impracticable for persons who have received preparatory training to keep up regular practice. Such persons, however, are very valuable in time of a disastrous explosion, since their training and instruction in the use of the apparatus enables them to be of great assistance to a crew of rescuers who may arrive with a breathing apparatus.

CONFIDENTIAL EMPLOYMENT DEPARTMENT

10. A good drill repair man wanted on a large railroad contract in the Middle States.
11. Air compressor engineer now employed. Takes charge of all repairs, steam or electric drive.
12. Compressor runner and repairer, Kentucky or Tennessee. Ten years' experience.

13. Educated man of large experience as master mechanic, chief engineer or electrician. At present holds position of chief operating engineer and electrician of large railroad shops. Prefers position east of Mississippi.

14. Has had experience in running air compressors. Would like position as compressor engineer.

15. Has been assistant master mechanic in large rubber factory and later master mechanic of granite quarry. Familiar with steam engines, electric motors, air compressors and rock drills. Live young man.

16. Was chief engineer of large marble quarry 10 years. At present compressor engineer on tunnel contract. Would like permanent position as chief engineer.

17. Has been engineer for building contractors. Familiar with engines, hoists and compressors.

THE UNSINKABLE SHIP

The new battleship Pennsylvania and its two immediate predecessors, now under construction, the Nevada and Oklahoma, of the United States Navy, are to be equipped with a novel installation for localizing and minimizing the effects of under-water injuries. The scheme broadly means nothing short of turning all of these water-tight divisions into so many separate caissons, from which the water can be expelled or held within limits through the medium of compressed air.

It has commonly been supposed that the system was in a sense the outcome of the foundering of the Titanic, but as a matter of fact the general plan antedates that catastrophe by many months—in short, is the direct consequence of the last efforts made to save the United S. S. cruiser Yankee in 1908. It is another case of where unsuccess has taught a profitable lesson.

The United S. S. Yankee hit the rocks of "Hen and Chickens Reef" outside of Newport and was stranded in a particularly awkward manner. Three experienced salvage companies essayed to refloat the cruiser for the Government, but after weeks of fruitless efforts they abandoned the undertaking as hopeless. But by means of compressed air the vessel was given enough buoyancy aft to permit of her being dragged from her lodgment upon the reef. Unfortunately, she was run into and sunk while being towed to harbor. Again, her

salvors, Messrs. W. W. Wotherspoon and R. O. King, undismayed by that casualty, struck out upon still more novel lines. The 'tween-deck spaces were divided into air chambers and successively sealed, and air locks were formed by utilizing existing ammunition hoists. When everything was ready compressed air was pumped into these improvised caissons and the vessel started to rise—in fact, actually reached the surface; but one of the temporary air locks proved unequal to the pressure, burst, and the ship filled and sank again. That accident proved extremely instructive to Mr. Wotherspoon, and also suggested to him how it would be possible to make any fighting ship virtually not only her own self-contained salvage plant but practically unsinkable.

As is well known, every man-of-war is subdivided from a point above the water line to her keelsons into many hundred separate water-tight compartments, for the logical purpose of confining injury should the outer and inner bottoms be pierced. All of these divisions are connected to an extensive drainage system, and ordinarily powerful pumps are counted upon to overcome leakage or to fight on more or less equal terms against the invading sea. If a compartment filled, notwithstanding the pumps, and the invasion stopped there, then the consequences might not be very serious. But, unfortunately, the pressure upon bulkheads and decks is often too great; hence they yield, and the neighboring compartments are likewise inundated. The pumps then have far more than they can combat and the ship is either heeled over so that she is put *hors de combat* or she goes to the bottom. This gradual giving way of the structure may occupy a period of many hours, and yet the ship is certainly doomed because of the one-sided stresses upon decks and bulkheads.

Mr. Wotherspoon actually subdivides a ship equipped with his installation into successive strata or layers of compressed air zones, and he distributes these as the emergency arises so as to meet the requirements of each exigency. In other words, the pressure of the air on the opposing sides of a deck or bulkhead is such that the resultant difference on the side of greater pressure is a number of pounds less per square inch than would be the case if the compartment were filled with water and flanked only by normal atmospheric

conditions. In this manner the structure of the damaged space is supported by the enveloping body of the ship throughout a pretty wide area, and this effectually guards against the yielding of the walls directly encompassing the damaged region.

Offhand the criticism first offered to the scheme by the naval authorities at Washington was that the equipment would involve too much weight would be very costly to put in place and would substantially mean the clearing out of most of the compartments for that purpose. This was the reply to the inventor's proposal that some one of the larger vessels already in service should be fitted experimentally. Mr. Wotherspoon met all of these objections and the armoured cruiser North Carolina was chosen for the test installation. It was elected to connect the apparatus with something like 800 of the ship's water-tight compartments, and the naval constructors were decidedly miserly in the total weight allow-

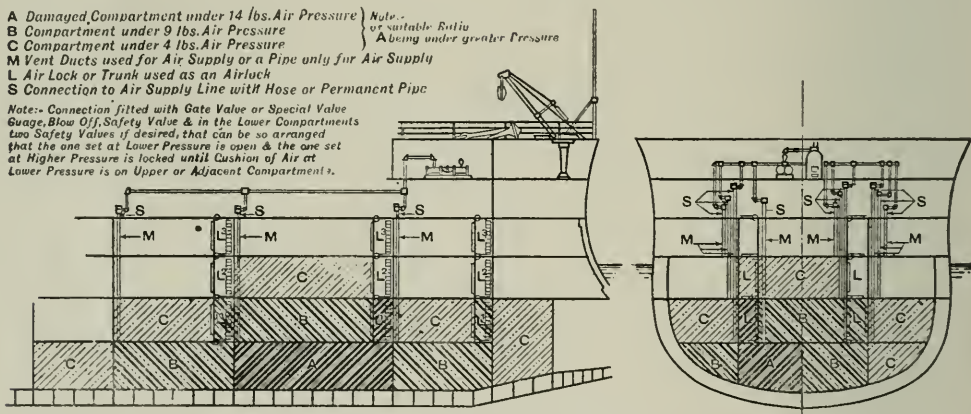
conduits already in place stood ready to serve another purpose. By these channels Mr. Wotherspoon can lead compressed air to any of the compartments and the only additional apparatus needed for this work is a flexible attachment for effecting connection with a source of air supply. Originally this was the air compressors but it is now intended to have air stored in reserve in sufficient quantity to help toward the immediate checking of any dangerous admission of water.

A supplemental feature is that of air locks extending from the uppermost water-tight deck down to the lowest water-tight spaces, and these air locks, by means of suitable vertical doors—not the top doors—on each deck make these convenient passageways between decks for all ordinary traffic.

The athwartship section given herewith shows the general arrangement of the system upon one of the United States naval vessels. Compartment A is the damaged one, and

A Damaged Compartment under 14 lbs. Air Pressure }
 B Compartment under 9 lbs. Air Pressure } Note:—
 C Compartment under 4 lbs. Air Pressure } or suitable Ratio
 M Vent Ducts used for Air Supply or a Pipe only for Air Supply } A being under greater Pressure
 L Air Lock or Trunk used as an Airluck
 S Connection to Air Supply Line with Hose or Permanent Pipe

Note:—Connection fitted with Gate Valve or Special Valve
 Gauge, Blow Off, Safety Valve & in the Lower Compartments
 two Safety Valves if desired, that can be so arranged
 that the one set at Lower Pressure is open & the one set
 at Higher Pressure is locked until Cushion of Air at
 Lower Pressure is on Upper or Adjacent Compartment.



SECTION OF BATTLESHIP PENNSYLVANIA.

ance which they granted the pneumatic engineer.

As is common knowledge among naval men, the underwater compartments of all men-of-war are forcibly ventilated to guard against the accumulation of gases and foul air. This is effected by a double system of piping, one carrying fresh air into the compartment and the other supplying an outlet for the tainted exhaust. Running down below the water line as it does all of this piping is subjected to pressure tests and must be equal to any tax which may be placed upon it by water pressure due to flooding, and therefore these

theoretically is under an air pressure of 14 lb. to the square inch. The contiguous compartments B B B are filled with air at a pressure of 9 lb. per square inch and this leaves a resultant bursting pressure upon the walls of compartment A of only 5 lb. per square inch. The outlying spaces C C C are charged with air at a pressure of 4 lb. per square inch and again this leaves a resultant bursting pressure of 5 lb. within compartments B B B. Therefore instead of the walls of the damaged compartment A having to withstand the entire stresses due to the confined air at 14 lb. pressure per square inch the flanking

and superposed enveloping ship fabric is bearing its part progressively. The longitudinal section gives another idea of the distribution of the various air strata or zones and the cushioning effect of this arrangement is obvious.

Despite the weight limit placed upon Mr. Wotherspoon, he effected his installation with a very material saving. Indeed, there was very little needed for the equipment, save some special valves, which was not already on board the North Carolina, and the ship's artisans' did most of the work of installation.

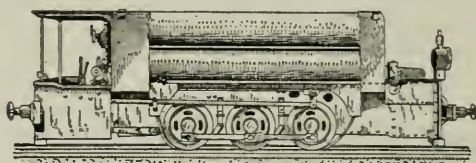
According to the building specifications of every fighting craft all of the water-tight compartments are required to be tested some time during the ship's construction. This test for water-tightness when carried out does not involve pressure testing to any pronounced extent and the spaces are seldom, if ever, filled as they would in all probability be in case of flooding due to damage. But, apart from this, the very complexity of the craft requires the placing of many mechanisms before decks are built over and other work finished. Some of this plant is of a nature which prohibits the subsequent testing of the compartments by water, and water-tightness is taken for granted and assumed on the score that workmanship and paint have made them so. These have proved a flimsy reliance, and in the case of the North Carolina, it was found that more than one compartment was leaky when the compressed air was used. Not only was this so, but a good many water-tight doors theoretically perfect proved to be anything but tight. In most cases this was found to be due to worn gaskets and loosened fittings, but these potential leaks would have escaped notice but for the telltale hissing of the liberated air. Thus, apart from its virtue in case of injury to the bottom platings, the system as installed upon the North Carolina showed how valuable it could be in checking the water-tightness of the craft within its own body structure. The secondary usefulness might easily resolve itself into one of prime importance under some conditions.

Mr. Wotherspoon has made his system alike valuable for the smothering of fires as well as for the arresting of leakage. Instead of turning compressed air into a compartment he chokes out a conflagration by using the same conduits to carry a gas which will not support

combustion into the endangered division.

A third advantage of this dual fire-and-water protecting system is the peculiar facility which it offers for making temporary repairs. By means of the air locks it is possible for the men to enter an affected compartment and to overhaul a leaky valve and replace it without any inconvenience. Again, should the injury involve a rupture of the ship's inner or outer plating, that, too, can be temporarily stopped or plugged or otherwise sealed as the occasion may best afford. The men would simply be working in the structural double of a caisson.

While Mr. Wotherspoon has confined the application of his system so far to the heavy battle craft of the United States navy, there is no reason why the same installation should not be adapted to the higher classes of merchant craft as well.—*The Engineer, London.*



TESTS OF TUNNEL COMPRESSED AIR LOCOMOTIVES

For the construction of the Mont d'Or tunnel the A. Borsig works, Berlin-Tegel, Germany, have delivered two locomotives of different types; one a three-axle of 11 tons weight and the other a four axle of 31 tons, both with compound air cylinders and double preheating of the air.

The air is carried at high pressure in two long cylindrical tanks, and after coming from the pressure reducing valve it passes through a special set of heater pipes before entering the high pressure cylinder and doing that portion of its work. In passing from the high pressure to the low pressure cylinder it is led through a second set of similar heating pipes. The cut shows the general features of the design of these machines.

The furnace for heating the pipes is on the locomotive frame, a small stack being provided in the front part of the locomotive to take care of the gases of combustion. Coal and charcoal are used for fuel in order to obtain a practically smokeless combustion. The preheating is such as to raise the temperature of the air in both cylinders to about 180 deg. cent. (356 deg. fahr.) With a grade of 0.13

	Small	Large
Number of cars.....	9	15
Kind of cars.....	box cars	15 tip wagons, 1 box car
Light weight.....	2.2 tons 4840 lb.	2 8 or 2 2 ton 6160 or 4840 lb.
Gross weight.....	8.4 tons 18480 lb.	11.6 or 8.4 ton 25520 or 18480
Duration of run, min.....	10.5	20.5
Length of run, m./yards.....	1000/1093	1870/2043
Speed m. per sec./ft. per sec.....	1.59/4 77	1.52/4 65
Initial pressure in the air tanks, atmospheres.....	84	68
Final pressure in the air tanks, atmospheres.....	29	23
Number of readings taken.....	10	19
Grand average pressure in the working flask, atmospheres.....	15	15 5
Temperature of the entering air at beginning of run:		
high-pressure cylinder, cent./fahr.....		80/176
low-pressure cylinder, cent./fahr.....		80/176
Temperature of entering air at end of run:		
high-pressure cylinder, cent./fahr.....	80/176	64/147.2
low-pressure cylinder, cent./fahr.....	45/113	58/136.4

TABLE 1.

per cent, the larger locomotives can haul up to 180 tons, and the smaller up to 55 tons gross (in all cases a metric ton of 2,200 lb. is meant).

An account of a series of tests of these locomotives has been published in *Glückauf*. The data are interesting particularly on account of the scarcity of tests of tunnel locomotives under operative conditions, tunnel construction being usually done under conditions

and guarantees as to the time of delivery which permit no interruptions for the purposes of tests. During the tests the locomotive was in front of the train when it moved tunnelwards, and behind when it moved out of the tunnel. In normal operation the opposite arrangement is of course used, since with a grade of 0.13 per cent. and the heavy train used, a break of a coupling would cause great danger unless the locomotive was always be-

EUROPEAN UNITS

	Length of Run, m.	Gross Load, t.	Output, tkm.	Useful Load, t.	Tractive Effort Locomotive and Train, Kg.	Output I. H. P., Hr.	Consumption of Air		
							Total Cbm.	Per Tkm. Cbm.	Per H.P.-Hr., Cbm.
SMALL LOCOMOTIVES	1000	76.35	76.35	55.80	1627	6026	123.75	1.621	24.317
	1000	76.35	76.35	55.80	60	0/222	4.50	0.059	24.324
AMERICAN UNITS									
	Miles	Tons Am.	Too-Miles	Tons Am.	Lb.		Cu. Ft.	Per Ton-Mile, Cu. Ft.	Per H.P. Am.-Hr., Cu. Ft.
Upgrade.....	0.621	69.4	43.09	50.7	3579		4332	32	840
Downgrade.....	0.621	69.4	43.09	50.7	132		138	1.22	840
EUROPEAN UNITS									
LARGE LOCOMOTIVE:	1870	183.20	324.58	135.2	3645	25245	459.00	1.34	22.611
	1770	183.20	324.26	135.2	100	0.656	13.26	0.04	23.806
AMERICAN UNITS									
Upgrade.....	1.16	166.3	192.90	125.8	8019		16065	26.3	783
Downgrade.....	1.09	166.3	181.267	114.2	220		455	0.79	825

TABLE 11.

low grade from the train. To take care of that during the tests, there was always a second locomotive at some distance on the other side of the train. Both locomotives were tested just as they were, without previous overhauling or even cleaning. Previous to the tests they had been over a year in actual service on the construction. The air capacity of the tanks could be established only by calculation, and was found to be for the small locomotive 78.75 cu. ft., and for the large locomotive 357 cu. ft. The comparatively low temperature of preheating indicates that the smoke stack was choked up, the temperatures obtained at the delivery tests having been considerably higher. The author states, however, that temperatures of 45 to 54 deg. cent. (113 to 129.2 deg. fahr.) in front of the low-pressure cylinder are about as high as one can go economically with this kind of locomotive where strong preheating permits the expansion of the air to be driven very high in the cylinder. The data of the tests are given in Tables 1 and 2.

BUREAU OF MINES BILL SIGNED

President Taft on February 25 signed a bill which defines more clearly the functions and broadens the scope of the Federal Bureau of Mines. This act is the first general recognition by the Federal Government of all branches of the mining industry. Representative Foster, chairman of the House Committee on Mines and Mining, speaking on the subject, said: "The Bureau of Mines retains its original name under the law, but it becomes a bureau of mining, metallurgy, and mineral technology, and this represents the wider scope of the new organization." The purposes are better to safeguard the lives of the men engaged in hazardous occupations, to prevent unnecessary waste of natural resources and to aid in the general upbuilding of mining.

OWNERS OF MINING STOCK MISSING

Four men who dropped from sight in the Spokane country several years ago are being sought by directors of the Tamarack & Chesapeake Mining Company. The four men have an aggregate of 7,250 shares of stock in the mine, which they secured when the property was but a prospect whose stock went for from 3 to 5 cents a share. To-day it is bring-

ing \$1.55 a share, making their holdings worth \$11,347.50. Patrick Turley, H. L. Stoddard and A. L. Humphrey were miners in the employ of the company and took shares for their wages on a basis of 5 cents per share. In this way Turley secured 4,250 shares, now worth \$6,587.50, and Stoddard and Humphrey took 1,000 shares apiece, making the value of the holdings of each \$1,550. F. E. Hemenway, the fourth man, bought 1,000 shares at 3 cents while employed as a cabdriver in Spokane.

ENTERING A COAL MINE AFTER AN EXPLOSION

Great precaution is necessary in entering a mine after an explosion if the lives of rescuers are not to be imperilled. First of all, the ventilation has to be restored. If the fan or fan-house is wrecked it has to be repaired in the quickest possible way. Enter the mine with the intake of air, and repair the air course enough to restore ventilation. A safety-lamp ought always to be used in advance work to guard against after-damp explosions. Where rescue apparatus is used the difficulties for rescue work are more quickly overcome. In igniting a small body of fire-damp the biggest proportion of after-damp is carbon dioxide; the same result will be found in a pure fire-damp explosion.

NOTES

On page 6718 of the February issue of COMPRESSED AIR MAGAZINE there appeared an illustrated article describing the operating of water gate valves by means of compressed air motors. This was properly credited by us to *Insurance Engineering*, from which it was taken by us. It originally appeared, however, in *Ideal Power*, and we are glad to thus call attention to the fact.

A 15,000-hp Pelton wheel, believed to be the largest unit of its type in Europe, is being installed in the Löntsch hydro-electric power station on the Klönthalensee near Glarus. The present installation consists of six 6,500-hp Pelton wheels, directly connected to their respective generators. The new unit will increase the capacity of the station from 39,000 to 54,000 hp, making it the largest in Switzerland.

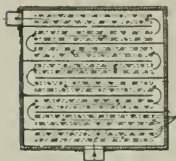
The State Mine Inspector of Montana reports that the development work in Butte during the past year was 57 per cent. greater than any year in its history. The Anaconda company alone did 30 miles of underground work, and the other companies, even the smallest, did their share.

Two tunnel explosions occurred at Chicago, on January 14 and 15, in a branch water-supply tunnel, at about 72d St. and Cottage Grove Ave. Pockets of natural gas are considered as the cause of both accidents. The first occurred about 11.30 p. m., and three men were

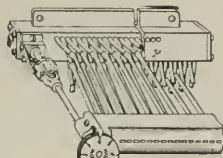
has now progressed to the point of having 8 miles of roadbed graded and ready for laying rails and putting in bridges. This railroad is being built under the direct supervision of the Government of Guatemala. On account of the ascent to be overcome, about 40 miles of track will be necessary to make the distance of about 30 miles between the two cities named.

LATEST U. S. PATENTS

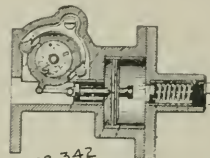
Full specifications and drawings of any patent may be obtained by sending five cents (not



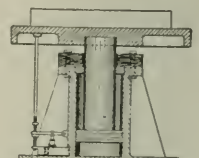
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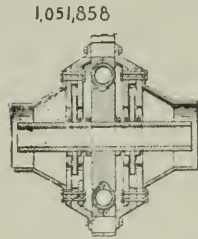
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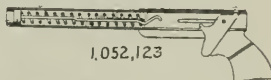
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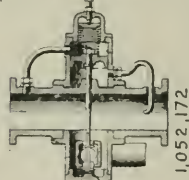
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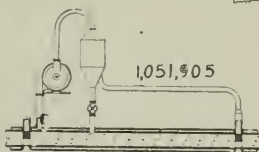
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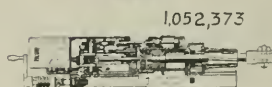
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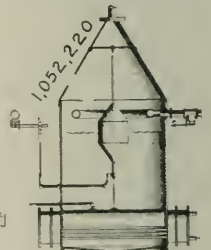
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1,051,905



1,052,373



1,052,220

PNEUMATIC PATENTS FEBRUARY 4.

badly burned. The second occurred about 5 a. m., killing one man and injuring eight more.

During the year 1912 the United States exported mining machinery to the value of \$8,138,328; coal—exclusive of bunker—to the value of \$18,148,767. During the same time there were imported 1,608,350 tons of bituminous coal, and coal-tar colors and dyes to the value of \$7,316,697. The balance was on our side, but it took substantially all the mining machinery we exported to pay for the coal-tar products, which we should have made in large part ourselves.

The Ferrocarril de los Altos, in construction between San Felipe (terminus of a branch of the Guatemala Central Railroad, at 2,056 feet elevation) and Quezaltenango, second city in size of the Republic, at 7,800 feet elevation,

stamps) to the Commissioner of Patents, Washington, D. C.

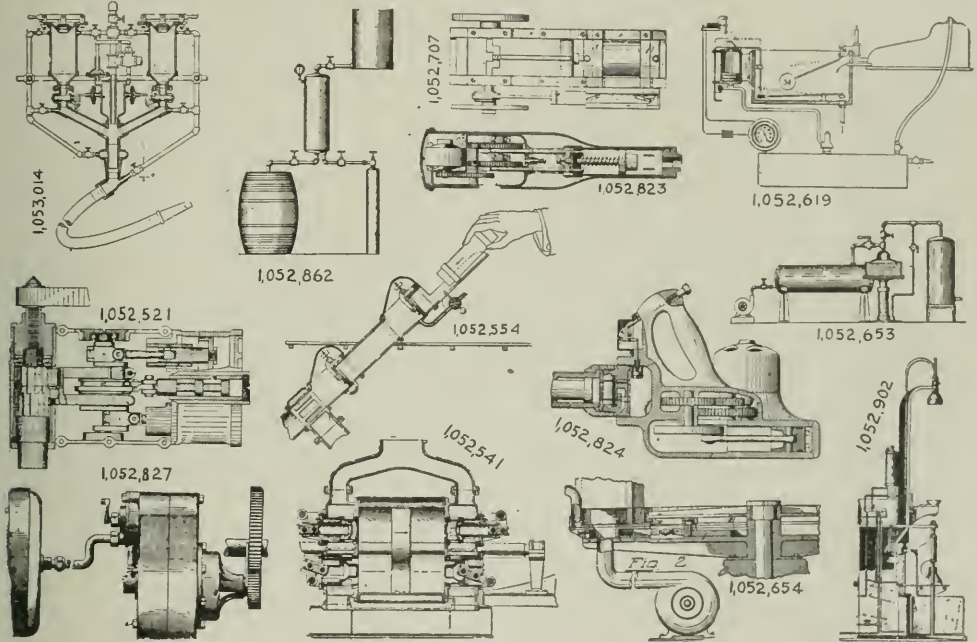
FEBRUARY 4.

- 1,051,858. PNEUMATIC HUB. HUBERT B. BIGSBY and WILLIAM M. LEWIS, New Hartford, Iowa.
- 1,051,905. CONVEYING SYSTEM. ALVIN C. MCCORD, Chicago, Ill.
- 1,052,081. MANUFACTURE OF HANDLES OF PLASTIC MATERIAL. ERNEST MILTNER, Newark, N. J.
- 1,052,086. JOLT RAMMING APPARATUS. EDGAR H. MUMFORD, Plainfield, N. J.
- 1,052,123. AIR-GUN. BURTON B. BENNETT, Plymouth, Mich.
- 1,052,138. TRANSPOSER FOR PNEUMATIC MUSICAL INSTRUMENTS. JOHN J. DOSERT, Syracuse, N. Y.
- 1,052,172. AUTOMATIC RELIEF-VALVE FOR FLUID-IMPELLING APPARATUS. AUGUSTE CAMILLE EDMOND RATEAU, Paris, France.
- 1,052,216. APPARATUS FOR ABSORBING CARBONIC ACID FROM AIR. CHARLES CHRISTIANSEN, Gelsenkirchen, Germany.
- 1,052,220. PROCESS AND APPARATUS FOR TREATING LIQUIDS. EUGENE W. DEMING, New York, N. Y.
- 1,052,342. TRIPLE VALVE. EPHRAIM K. HUTCHINSON, Ely, Nev.
- 1,052,373. ROCK-DRILL. ALEXANDER PALMEROS, Syracuse, N. Y.

FEBRUARY 11.

- 1,052,521. END-SPINDLE AIR-DRILL. ARTHUR SCOTT, Cleveland, Ohio.
 1,052,541. GAS COMPRESSOR AND PUMP. ARTHUR J. WEST, Bethlehem, Pa.
 1,052,554. VALVE FOR PNEUMATIC-DESPATCH-TUBE APPARATUS. WILLIAM H. AMES, Easton, Mass.
 1,052,619. AUTOMATIC CONTROL FOR AIR-COMPRESSORS. WILLIAM L. PICKETT, Bridgeport, Conn.
 1,052,653. PNEUMATIC MEASURING - MACHINE. JOSEPH P. CROWLEY, Toledo, Ohio.
 1,052,654. MEASURING-MACHINE FOR TOBACCO, &c. JOSEPH P. CROWLEY, Toledo, Ohio.
 1,052,707. AIR-ENGINE. FRIEND A. ALLEN, Granger, Mo.
 1,052,823. POWER-ACTUATED HAND-TOOL. ALBERT M. IRVINE, Philadelphia, Pa.
 1,052,824. POWER-ACTUATED HAND-TOOL. ALBERT M. IRVINE, Philadelphia, Pa.
 1,052,862. PROCESS OF PICKLING MEATS.

- 1,053,333. PERCUSSIVE TOOL. CHARLES H. HAESELER, Philadelphia, Pa.
 1,053,412. PNEUMATIC CONVEYER. GUIDO E. LOB, Chicago, Ill.
 1,053,427. ACETYLENE - GAS APPARATUS. ANDREW MOSER, Hickman, Nebr.
 1,053,452. APPARATUS FOR TRANSPORTING LIQUIDS OR GASES. EDWARD C. STOVER, Trenton, N. J.
 1,053,581. ELECTRIC PNEUMATIC SWITCH. JOHN DESMOND, Chicago, Ill.
 1,053,666. AUTOMATIC EQUALIZATING - VALVE. ARMSTRONG M. STARKEY, McKinney, Tex.
 1,053,696. TRIPLE VALVE FOR AIR-BRAKE SYSTEMS. CHARLES H. ATKINS, Springfield, Mass.
 1,053,793. GAS AND AIR MIXER. ARTHUR DOCKING, Nottingham, England.
 1,053,802. HUMIDIFIER. WILLIAM H. FLETCHER, Paterson, N. J.
 1,053,904. AIR-COMPRESSOR GOVERNOR. RUDOLPH CONRADER, Erie, Pa.

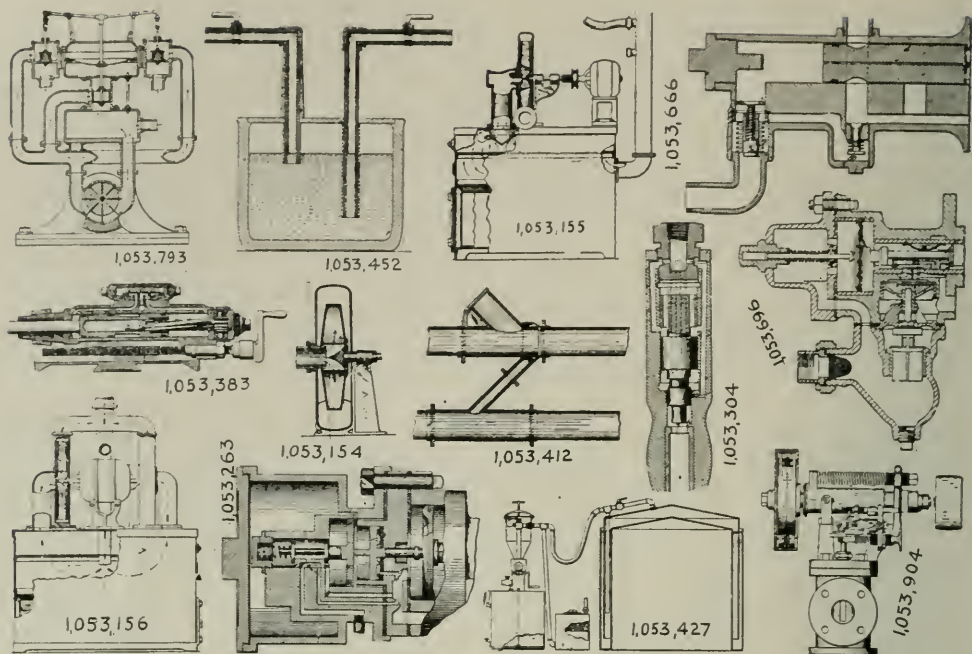


PNEUMATIC PATENTS FEBRUARY 11

FEBRUARY 25.

- CHARLES B. TRESCOTT, Indianapolis, Ind.
 1,052,902. GLASS-BLOWING MACHINE. VERNON M. DORSEY, Laurel Grove, Md.
 1,053,014. PNEUMATIC PLASTERING - MACHINE. PETER L. CRON, Elizabeth, N. J.
 1,053,093. PRESSURE - ACTUATED TOOL. GEORGE H. GILMAN, Claremont, N. H.
 FEBRUARY 18.
 1,053,154. CENTRIFUGAL FAN. CHARLES G. CAMPBELL and MONROE BENBROOK, Milwaukee, Wis.
 1,053,155. VACUUM - CREATING APPARATUS. CHARLES G. CAMPBELL and MONROE BENBROOK, Milwaukee, Wis.
 1,053,156. AIR-CIRCULATING SYSTEM FOR VACUUM-PRODUCERS. CHARLES G. CAMPBELL and MONROE BENBROOK, Milwaukee, Wis.
 1,053,263. AUTOMATIC FLUID - BRAKE. LOUIS H. ALBERS, Albany, N. Y.
 1,053,246. LOAD-BRAKE APPARATUS. WALTER V. TURNER, Edgewood, Pa.
 1,053,304. PNEUMATIC TOOL. HENRY E. LE GENDRE, Creskill, N. J.

- 1,053,968. BLOWPIPE. LEON L. BOWER, Philadelphia, Pa.
 1,053,991. COMBINED MOTOR AND AIR-PUMP. JOHN CHARLES HENDERSON, San Francisco, Cal.
 1,054,056. MOISTURE-EXTRACTING APPARATUS. JOHN S. THURMAN and LYNNÆUS I. LOCKWOOD, St. Louis, Mo.
 1,054,060. SOLDERING APPARATUS. WALTER ULDRICH, Leipzig, Germany.
 1,054,080. METHOD OF COMBINING AIR AND GAS AND UTILIZING THE SAME IN AN INTERNAL COMBUSTION ENGINE. GUSTAV A. BACHMANN, Baltimore, Md.
 1,054,211. AIR-COMPRESSOR. JUSTUS R. KINNEY, Dorchester, Mass.
 1,054,343. PNEUMATIC TOOL. CHARLES A. FAESSLER, Buffalo, N. Y.
 1,054,417. FLUID-PRESSURE CONTROL OF TRANSOMS AND WINDOWS. JOB HUTCHINSON, New York, N. Y.



PNEUMATIC PATENTS FEBRUARY 25.

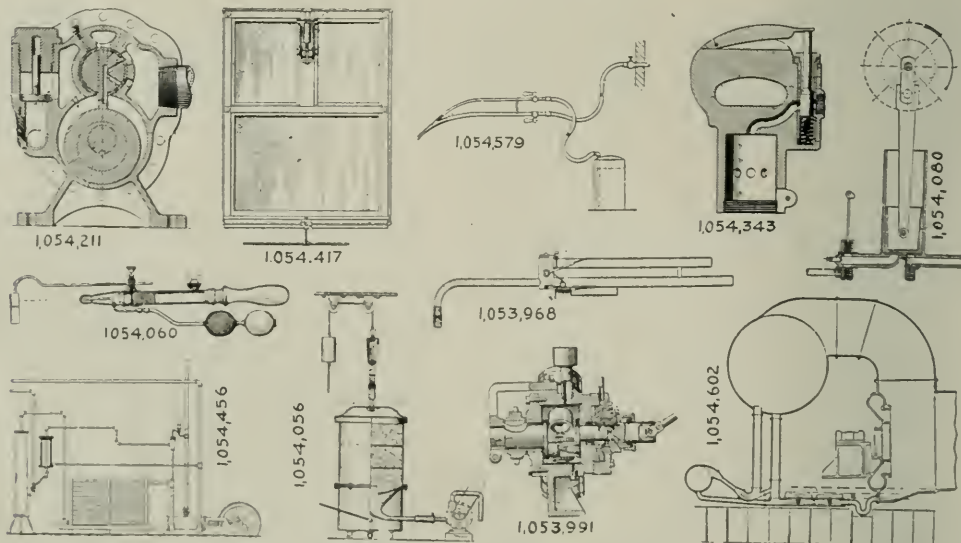
1,054,456. SAFETY ATTACHMENT FOR COMPRESSION REFRIGERATING APPARATUS. FRITZ A. SCHNEIDER, New York, N. Y.

1,054,579. CLEANING DEVICE. PATRICK ANDREW MAHON, New York, N. Y.

1,054,589. DEVICE FOR THE PRODUCTION OF PURE AIR. HUGO MESTERN, Berlin, Germany.

1,054,602. CONDENSING APPARATUS. CHARLES ALGERNON PARSONS, Newcastle-upon-Tyne, and STANLEY SMITH COOK, Wallsend, England.

1,054,650. PROCESS OF AND APPARATUS FOR MANUFACTURING DRIED FOOD PRODUCTS. MAURICE VOUGA, Neuchatel, Switzerland.



PNEUMATIC PATENTS FEBRUARY 18.

COMPRESSED AIR

MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XVIII

MAY, 1913

No. 5



A WATERFALL FROM AN AIR LIFT.

AIR LIFT PUMPING

BY CHAS. A. HIRSCHBERG.

It is now some twenty odd years since Dr. Pohle advanced his theory of pumping water by compressed air and the first air lift plant was installed, and we have come to accept it as a matter of course, some of us scarcely realizing its real importance to thousands of municipalities, manufactories and private establishments, such as hotels, office buildings, etc.

Let us consider for a moment the points of merit possessed by this system that have caused it to be so generally accepted and recognized as a desirable, efficient and simple means for not only pumping water, but as a semi-liquid transmitter.

There is no mystery connected with its operation; on the contrary, simplicity is the dominant feature, both as to installation and operation, while economy falls short of the proper

description when thought of in connection with attendance and maintenance. The man with a pumping problem, upon seeing the air lift in operation, wonders at the simplicity of the equipment, and the very numbers of its installations overwhelmingly attest its success.

As an eliminator of trouble and labor, it ranks high; in fact it heads the list of all pumping methods. Think of not having any pump to watch, distant and individual plant installations to make and take care of, no sinker rods to break and wear out and in-so-far as the well itself is concerned, no mechanical movement whatever to act as a constant source of annoyance and expense. This latter point in itself is of sufficient importance to recommend the use of an "Air Lift" in preference to other systems; it is a guarantee that it is no longer requisite to keep five or six men on the job to haul out from twenty to thirty connecting pieces and pipes for some irksome repair, while the water supply is crippled until the damage can be adjusted or repaired.

The Air Lift system is only limited by the capacity of a well to yield water. It will not only pump all the water which a well will deliver, but will increase its capacity with service owing to the cleaning action exerted. It carries off the sand and earth, permitting a more ready inflow of water, whereas with ordinary pumps the natural tendency is to clog the well, or, if sand and dirt are carried into the pump, to injure and impair the action of the pump itself.

The theory of the Air Lift has been expounded so often and is so well understood, that it is not the writer's purpose to go into a long dissertation on the subject. Summed up briefly, this system involves the use of an air compressor located at the most convenient point irrespective of the location of the wells; an air receiver adjacent to the compressor, a pipe line for conveying the air from the receiver to the wells, one or more wells drilled to a depth proportioned to the height of the lift and the depth of the water below the surface, air and water pipes running down inside of these wells, the proper proportion of their vertical length submerged when at work, representing the pumping apparatus proper.

USES FOR THE AIR LIFT.

City and town water-works, asylums and hospitals, plantations, railway water tanks, irrigation, private country houses, pumping mines, ice manufactories, breweries, cold stor-

age and packing houses, textile mills, dye works, bleacheries, sewerage installations, dry docks, seaside water-works, stock farms, etc. In fact, anywhere and everywhere that clear and abundant water is needed.

In many cases private water companies and cities have installed water meters to measure the amount used by manufacturing concerns, and the cost of water has therefore risen to such a point as to become one of the considerable expenses to any manufacturing plant. The insurance companies have also placed restrictions on such establishments and have made demands which make it desirable to have an independent water supply.

In addition to its value for raising water, compressed air lends itself with especial facility to the difficulties involved in handling brine from salt walls, for raising acids, acid solutions, and other liquids of high specific gravity and corrosive character. In manufacturing establishments it is used extensively for ore leaching, handling dye, paper pulp and fluids. In sugar refineries, and places where gritty particles and chemical solutions have to be handled, the air lift is being employed.

There are no working or moving parts of any sort in contact with the liquid, and in consequence the few pipes and tanks necessary for storage and moving the liquid can be made of materials unaffected by the fluid. Even wooden pipes are sometimes used.

Recent inquiry tends to show that a greater percentage of municipal water works than ever before are resorting to the air lift system of pumping; such plants are being installed at the present time at the following points; Matawan, N. J., Jamaica, L. I., Fulton, Ill., Howard Park, Md., Prescott, Ariz., So. Orange, N. J., Minden, Nebr., Fond du Lac, Wis., Huntsville, Tex., etc.

The installations treated in the following are typical of any number of such plants dotting the country and it would seem upon an examination that the merit possessed by this system is deserving of even greater recognition than now accorded it.

AN AIR LIFT TEST.

An air lift test was recently made in Indiana which affords an opportunity for comparison between the efficiency of the Air Lift System of pumping and one of the best and most economical deep well pumps made.

This Indiana water-works for over a year used a second hand 16 and 18 $\frac{3}{4}$ x18 inch

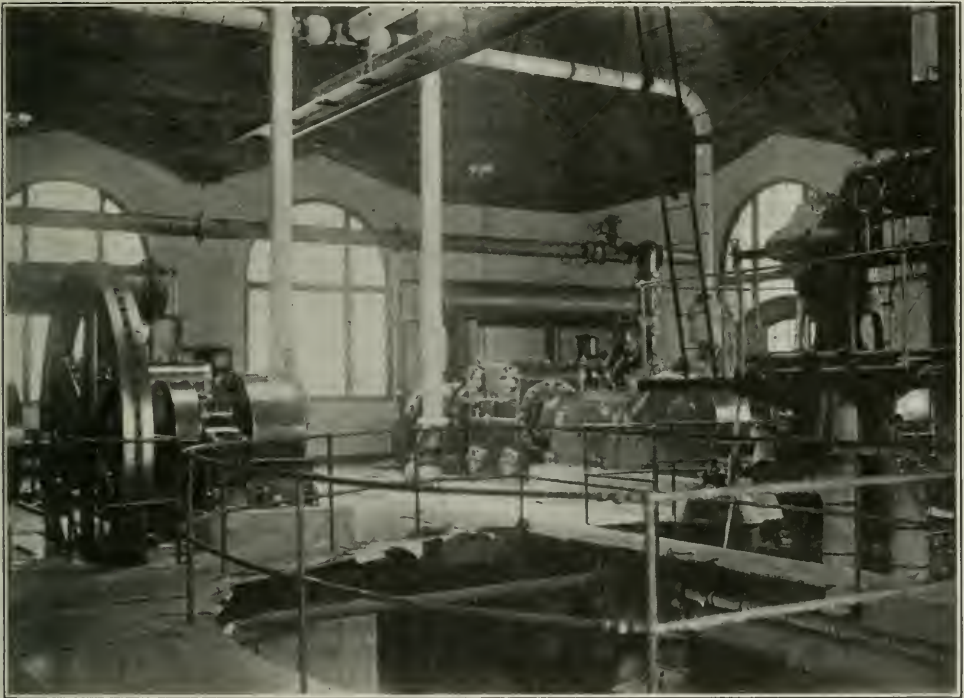
Class "A-1" Ingersoll-Rand compressor to operate an Air Lift furnishing a temporary water supply. Recently the pump company obtained permission to make a test and installed two of its belt-driven pumps with cranks and pitman, giving a double-acting effect with a definite length of stroke.

In this case the pumps were driven by an ordinary portable engine and boiler. The test was conducted by a well-known consulting engineer who was employed by the city to make tests to determine which system should be adopted. As a result of these tests, which

been increased by using Corliss compound compressors, and that a power driven deep well pump such as was used in this case is much much efficient than the more usual type, which is driven by a direct-connected steam head, so that the comparison would be about the same for average conditions.

SALT WELLS.

Brine of a profitable saturation is secured and the output greatly increased. Many such plants are using the air lift advantageously, special methods of piping avoid difficulties common to this class of well. An example of



COMPRESSOR ROOM PLAINFIELD UNION WATER COMPANY

were very thoroughly made, it was definitely shown that the deep well pump raised 60 gallons of water per pound of coal burned under the boiler while the Air Lift plant, under the same conditions, raised 300 gallons per pound of coal burned.

The test affords an idea of the relative efficiency under like conditions. Admitting a much higher efficiency for the pump in cases where economical engines are used, it should also be borne in mind that the efficiency of the air lift plant could have

unusual interest is the salt wells of a large Lumber Company. These wells are 2017 feet deep the last 30 feet of which is solid rock salt. They are cased 8 inches down to 616 feet the balance being a 7-inch uncased hole. A 4½-inch pipe extends entirely to the bottom of the wells, which provides an annular space around its outside between it and the walls of the wells. Inside of this pipe is a 3-inch liquid discharge pipe extending down 985 feet. At the bottom the outer pipe has a reducer fitted to it, so that if the 3-inch pipe

should rust through and drop it would be caught and could be pulled up by the outer pipe.

The fresh water is run down outside of the $4\frac{1}{2}$ inch pipe and kept up to within about 100 feet from the top of the well. It dissolves the rock salt at the bottom and is lifted up through the central 3-inch pipe, the air being forced down the annular space between the outside of the 3-inch and the inside of the $4\frac{1}{2}$ inch pipes.

The compressor is a straight line machine, with steam cylinder 22 inches in diameter, and compound air cylinders $18\frac{1}{4}$ inches and 9 inches, all with a 24-inch stroke. They pump three wells at a time, and with the compressor running at moderate speed about 600 gallons of brine per minute is secured.

MUNICIPAL WATER PLANTS—PLAINFIELD UNION WATER COMPANY, PLAINFIELD, N. J.

Until two years ago the Plainfield Union Water Company, supplying the city of Plainfield, used the direct suction method in connection with a 140 ft. reservoir to obtain the effective head, but as the water level was getting dangerously low extensive investigations were made regarding the best method of obtaining an increased water supply and allow for a lift beyond the range of suction pumps.

They finally decided that the Air Lift system possessed peculiar advantages that would prove the most convenient and economical method, special consideration being given to simplicity and reliability. They accordingly installed a small steam driven compressor and invited three manufacturers to run competitive tests to determine the most efficient and desirable method of air lift for their purpose. The Ingersoll-Rand Company, using Harris foot pieces, developed the greatest efficiency upon the preliminary tests, and on the strength of this the water company purchased two Cross-Compound Condensing Compressors, type OC-3, 27 inch stroke, with steam cylinders 20 and 34 and air cylinders $32\frac{1}{4}$ and $21\frac{1}{4}$ and fitted twelve 7 inch and 10 inch wells with Harris foot pieces; the depth of these wells varies from 300 to 500 feet, with casing to the rock at 90 feet. The average length of discharge pipe is 210 feet and the lift is approximately 89 feet.

Upon completion of the installation of the permanent plant a test was conducted to determine the over all efficiency, and after a careful adjustment of the wells very favora-

ble results were obtained. Three thousand, six hundred and six gallons of water per minute (3,606) was pumped from 8 wells. The lift in this test was $89\frac{1}{2}$ lbs. and 1583 cu. ft. of free air per minute was used at a pressure of 60 lbs. This work represented 82.85 water horse power and the indicated horse power in the stream cylinder of the air compressor was 211, giving an over all efficiency of nearly 40 per cent. It should be borne in mind that but one compressor was used in this test. This is as good a result as has ever been obtained from any air lift system under similar conditions.

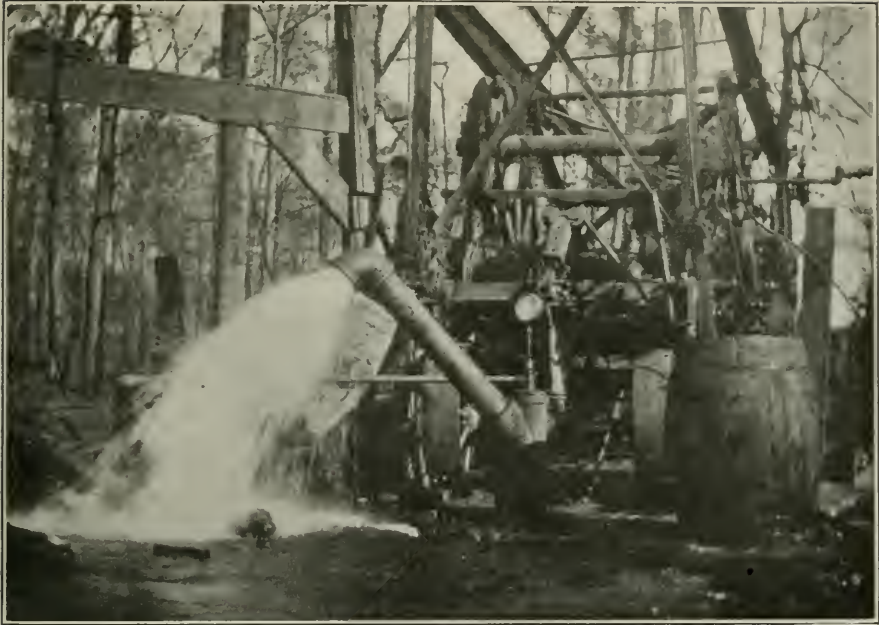
So far as the cost of operating this plant is concerned, it should be understood that this company is using steam pumps in conjunction with the air compressors, taking the water from the receiver on the ground and pumping it into a 140 foot stand pipe.

The Water Company was unable to determine just what the fuel consumption was of the air plant alone, but taking in conjunction with the steam pumps which were forcing the same volume of water against a head of 150 feet the entire plant was handling on an average day, approximately 5,700,000 gallons and consuming twelve tons of coal; taking \$2.60 as a fair price per ton, this would give about .0055 cents per thousand gallons delivered to the mains. This plant has now been running continuously for about eighteen months and no trouble whatever has been experienced with it.

So far as the cost of such a plant is concerned, the statement of the Water Company which is quoted herewith is the best argument that can be offered on the question.

"The first cost of this plant was considerable, but we feel that by buying carefully as we did and entrusting ourselves to thoroughly reliable people it has paid us in the long run. I do not hesitate to recommend the air lift for municipal work and have always found it reliable and safe."

The compressors installed are of the Duplex Corliss Steam Driven type, with steam reservoir placed transversely below the floor. The air cylinders are equipped with an overhead intercooler and a large water separator or moisture trap on the discharge pipe through which all air passes after cooling. The main frames are of the enclosed type and provided with a flood lubrication system. Automatic control of speed and pressure, and regulation of output to load, is provided for. The inlet



AIR LIFT DISCHARGE, GRIFFIN, GA.

valves are of the "Hurricane Inlet" type with Cushioned Direct Lift Discharge valves. Cylinders are completely water jacketed on heads and barrel. The entire design embodies great accessibility, the value of which cannot be over-estimated, as convenience of supervision plays an important part in the economical operation of such a plant.

REPORT ON AIR LIFT PLANT, CITY OF GRIFFIN,
GEORGIA.

Population of Griffin.....	7,478
Number of water connections.....	575
Total average pumping per 24 hours.....	200,000 gal.
Number of services metered.....	89%
Number of wells	4
Depths of wells.....	500 ft. each

Diameter of wells:

No. 1 and 2—	6½ inches top, 5 inches bottom.
No. 3 and 4—	8 inches top, 6½ inches bottom.
Number of gallons pumped with compressor per minute.....	500
Average number of hours wells are pumped per 24 hour day.....	7

Starting and working pressures:

No. 1 and 2.....	150 lbs. start, 80 running
No. 3	65 lbs. start, 45 running
No. 4	85 lbs. start, 70 running
Speed of the compressor,	175 RPM.

Size of compressor. 14 and 9 x 12, "Imperial"
Duplex Compound Belted.

System of piping for wells:

No. 1—Central Air Pipe System.
402 ft. of 4 inch discharge pipe.
365 ft. of 1¼ inch air pipe.
No. 2—Central Air Pipe System.
188 ft. of 4 inch. discharge pipe.
1 ft. of swedge nipple.
307 ft. of 3 inch discharge pipe.
495 ft. total length of discharge pipe.
307 ft. of 1¼ inch air pipe.
No. 3—Central Air Pipe System.
213 ft. of 4¾ inch discharge pipe.
179 ft. of 1¼ inch air pipe.
No. 4—Harris Air Lift, with 3 inch pump.
201 ft. of 3 inch discharge pipe.
10 ft. of 3½ inch pipe on bottom of pump.
201 ft. of 1 inch air pipe.

The water bearing stratum is a hard and medium granite formation.

Cost per thousand gallons distributed in the mains, 3¼ cents.

An analysis of the above figures shows that the total water pumped averages 270,000 gallons per day of 24 hours at a cost of \$8.77, or 1 17/100 mills per person.

COLORADO AIR LIFT PLANTS.

Twenty-five years ago the city of Denver, Colo., had flowing artesian wells in abundance, but with its growing population and increasing water consumption the average water



BROWN PALACE HOTEL, DENVER.

level receded to more than 200 feet from the surface, gradually compelling private water plants to resort to some means of raising the water from the wells. Hotels, office buildings, department stores and factories, one after another installed Air Lift plants as a solution of the problem until to-day Denver and its vicinity is literally dotted with them.

A plant typical of many is located in one of the city's largest and oldest hotels, The Brown Palace. Here an unfailing supply of wholesome, aerated, artesian water, cool, clean and

sparkling is furnished to all guest rooms as well as for general purposes, making the hotel entirely independent of city water supply, except for fire protection.

Water is pumped day and night from two 8 $\frac{5}{8}$ -inch driven wells located within the building. Each of these wells yields about 110 gallons of water per minute. The water stands approximately 220 feet from the surface, which is also the point of discharge. A starting air pressure of 130 pounds is required while the working pressure is 115 pounds. A duplex, steam driven compressor 12 and 18x16 and 10x14 of the Imperial type furnishes the air to a No. 7 Harris 20th Century pump, placed 510 feet from the surface with a submergence of 290 feet.

Another such plant is located at the Albany Hotel operated by a long belted-to-motor compressor, operating at less than half its rated speed, while a steam machine is held in reserve in case of breakdown in the electrical power line. This well yields probably more water than any of the wells working on the artesian underflow of Denver. The conditions of water level, submergence and air pressure are about the same in all Denver Air Lift plants with but few exceptions.

That this system of pumping water is well appreciated in "God's Country" is shown by the following more prominent list of such plants operating there:

The Mack Block, a large office building:



FIG. 1. PRUDENTIAL LIFE BUILDINGS, NEWARK, N. J.

the new Denver Gas and Electric Bldg., The Tabor Opera House Block, Clayton College, St. Thomas' Seminary, Denver Dry Goods Store, Colorado Ice and Cold Storage Co., Columbia Laundry, Equitable Office Building.

AIR LIFT FOR PUMPING DYES.

At the Hamilton Hosiery Mills, Chattanooga, Tenn., the Air Lift is put to a rather novel use; the transferring of dye liquor used in dyeing hosiery. The fluid is transferred from one iron tom-tom or kettle, holding about 55 gallons, to another of equal capacity.

These kettles drain into a barrel about 2 feet 6 inches deep, which is set flush with the floor. Through the bottom of the barrel a hole about 4 inches in diameter is bored and a pipe of this size carried down for about 8 feet. This gives the necessary submergence. The total lift from the bottom of the pipe to the discharge is 13 feet 6 inches. Each of the kettles is filled 15 to 17 times per day by this little lift, each operation requiring about $2\frac{1}{2}$ minutes. The saving in dye liquor by this scheme amounts to about $\frac{3}{4}$ of a barrel per day, and this, together with the saving in manual labor forms quite an item in the day's work. The compressor is a small one of the Imperial Vertical Type. While this is not a new application of the Air Lift System, it shows its versatility. Tanneries use this system successfully for changing tanning liquids.

THE HOME OF THE PRUDENTIAL INSURANCE COMPANY OF AMERICA, NEWARK, N. J.

Fig. 1 shows the five buildings comprising the Home of the Prudential. It occupies most of the block bounded by, Broad, Academy, Bank and Halsey Sts., and is remarkable for the growth which has taken place during the past twenty years both in building area and in that of the power plant, in the former from a single building to 5 with a total area of 690,000 sq. feet and in the latter from 50 H.P. to 5000 H.P.

Upon entering the Power Plant, with which we are concerned (and more particularly the Refrigeration Plant) one is immediately impressed with the fact that here a master-mind has been at work, and that no pains have been spared to attain the acme of the engineers' art, so as to serve the Homes' numerous occupants efficiently and economically.

From the figures below one may gain an idea of the size and scope of this power plant.

Population of building, stationary.....	5,000
Population of building, floating.....	8,000
No. of buildings	5
No. of floors to the buildings.....	12
Floor area approximately.....	690,000 sq. feet

The population of a fairly good sized city is represented here.

Economy of the highest order prevails in the plant arrangement, type of equipment, attendance and supervision. Up to three years ago the water for house purposes and for general power plant uses, was purchased from the city, but owing to the ever increasing consumption and attendant cost, it was decided to drive several wells and install a pumping plant, provision to be made for a still further increase in consumption during the years to come.

Four wells were accordingly sunk, located as shown in Fig. 2, and after a careful consideration of the various pumping methods available, the wells were equipped with Air Lift pumps, the air for which is furnished at 75 lbs. pressure, by two steam engine-driven compressors, of the duplex Ingersoll-Rand type.

These compressors operate day and night at an average speed of 70 R. P. M., 300,000 gallons of water being pumped from 4 wells.

The following gives the daily scheme of performance:

Size of compressors—12 and 20 and $12\frac{1}{4} \times 12$.

Speed of compressors—70 R. P. M.

Starting pressure—100 pounds.

Working pressure—70 pounds.

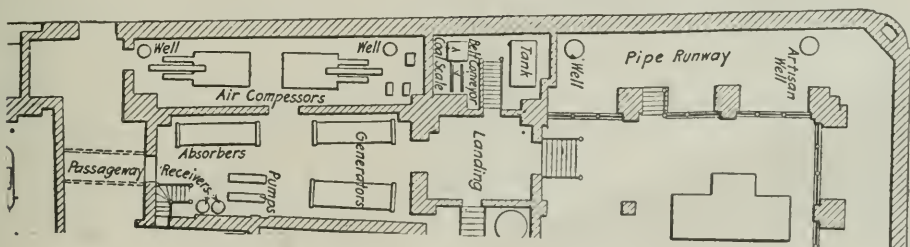


FIG. 2. LAYOUT OF WELLS.

Boiler pressure—150 pounds.

No. of wells—4.

Depths of wells—800 feet.

Piping in well—250 feet.

Size of wells—8 inches.

Submergence—150 feet.

Lift—108 feet to point of discharge.

Natural water level—80 feet.

No. of water taps—3,500.

Average pumping per 24 hours, 300,000 gals.

The method of piping the wells embodies a number of unique features. The foot pieces are of the Pohle Annular type, while the head pieces were designed especially to meet con-

ditions imposed here. Exterior view of one well is shown in Fig. 3. Fig. 4 shows a cross section of this well. The head piece consists of a slotted pipe enclosed by a large separating pipe and which is capped and provided with a Tee to the discharge line.

The water is discharged from all wells into a central surge tank shown in Fig. 5, from whence it is pumped into a tank in the North Building and distributed into the mains throughout the building under a pressure of 80 lbs. due to natural head. On account of its constant low temperature this water is excellent for use in the condensers of the refrigeration plant.

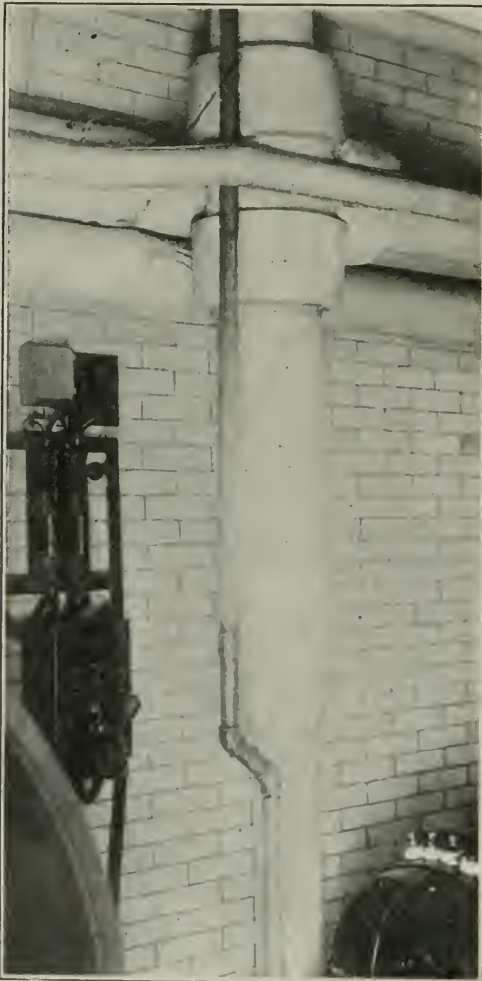


FIG. 3. ONE OF THE WELLS.

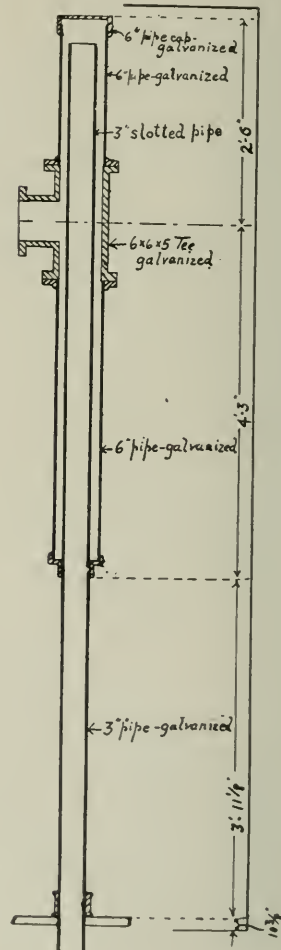


FIG. 4. SECTION OF WELL.



FIG. 3. THREE WELLS DELIVERING INTO TANK.

ACETYLENE DEVELOPMENTS

Consular Trade Reports give us some account of an exposition of acetylene apparatus recently held in Paris.

Among the numerous objects of interest were the so-called "light boxes." These require plunging in a pail of water when, by an ingenious mechanism contained in the box, the required amount of water automatically enters, and the gas generated is given off through tubing attached to the box and can be delivered any distance required. These boxes can thus be used at any moment and very economically to illuminate large open spaces, public fetes, etc. The boxes are useful for river and deep sea fishing. A floater is attached above the box, which is then immersed in the water.

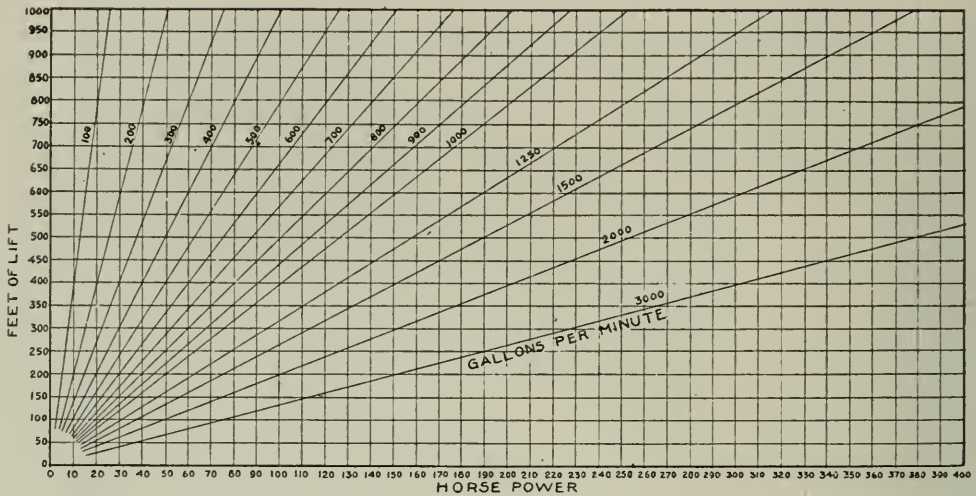
There was an exhibition by a firm which has undertaken large lighting contracts, including some 30 villages entirely lighted with acetylene.

The chief uses of acetylene, in which great progress is being made, are soldering, intensive generators for lighting construction works, works carried on by night, etc., mine lamps, hand lamps, insect-trap lamps for vines, etc., and automobile lamps, of which 700,000 are in use in the United States alone. It may be added that there are now 250 towns in France and Algeria lighted with acetylene.

In addition to its direct employment in the production of acetylene gas, calcium carbide is also used in the manufacture of cyanamid, a new outlet which offers almost unlimited possibilities of extension. Calcium carbide heated to a temperature of 1,000 degrees C. (1,832 degrees F.) absorbs a certain quantity of atmospheric nitrogen and changes into a new product, cyanamid, which has a chemical composition similar to that of guano and consequently has the same fertilizing qualities when employed in the same manner. When mixed with earth it is decomposed by the damp and yields both chalk and ammonia, which is oxidized into nitrates. Its efficacy is equal to that of sulphate of ammonia, of which the production for agricultural purposes exceeded 1,150,000 tons in 1911.

ONE OF THE SELF-STARTERS

The Pierce-Arrow automobile self-starter comprises an air pump on the forward end of the gear box, an air reservoir located horizontally above the muffler on the left side of the chassis, an air distributor on the motor which delivers the pressure to the cylinder in the firing position; a pressure gage on the dash and a control valve for bringing the air pump into operation whenever needed. There



THEORETICAL DIAGRAM OF POWER REQUIRED FOR LIFTING WATER.

is a jaw clutch mechanism between the air pump and the forward end of the countershaft in the gear box, by which the pump can be operated when desired through a control lever on the footboard.

The air from this pump is delivered into the tank where it is stored to a maximum pressure of 200 pounds. From this tank it is led to the air distributor, located on the left side of the motor, between the water pump and the lighting dynamo and driven by a continuation of the vertical oil pump shaft. From the air distributing housing, piping leads to special constructions in the cylinder heads, each of these containing a check valve. The control of the apparatus is from the floor boards, where there is also located a gage to show the air pressure in the tank.

The air distributor is a rotating disk, having a crescent-shaped slot. The air supply enters the cover of the distributor centrally and the air delivery pipes enter the distributor case beneath the disk. As the disk rotates its slot registers in firing order with the different cylinders delivering the air pressure to the one in correct position and to the other in sequence, so as to give a continuous turning movement to the crank shaft.

Air consumed in a blast-furnace, in making one ton of pig iron, amounts to 6 tons, while there are also used 4 tons of ore, coke, and limestone.

A WATER PUMPING DIAGRAM

BY FRANK RICHARDS.

The diagram here presented, which would seem to be entirely self explanatory, may be found convenient for ready reference in water pumping comparisons or in preliminary estimates of pumping requirements. It represents throughout the theoretical horsepower, or 100 per cent. efficiency, in pumping different numbers of gallons per minute to different heights, up to 1,000 feet.

The weight of the gallon being taken as 8.34 pounds the statement would be: Number of gallons per minute, multiplied by 8.34 pounds, multiplied by height of lift in feet, divided by 33,000 foot-pounds, equals horsepower.

Thus 500 gallons x 8.34 x 800 feet of lift ÷ 33,000 = 101 horsepower, as shown on the diagram.

It happens that the 500 ft. line is the highest horizontal line which is crossed by all the gallon "surves," and we may note upon that line that the horsepowers required for the different numbers of gallons raised to that height are as follows: 100 gallons, 12.6 horsepower; 200, 25.27; 300, 37.9; 400, 50.54; 500, 63.18; 600, 75.8; 700, 88.45; 800, 101.09; 900, 113.72; 1,000, 126.36; 1,250, 157.9; 1,500, 189.5; 2,000, 252.7; 3,000, 379.

CONSTANT PRESSURE AIR RECEIVERS

BY FRANK RICHARDS.

The following question has been brought to my notice with a request for an answer.

"If an air compressor has a capacity of 90 cu. ft. of free air per min., and delivers it at 90 lb. gage pressure, what volume does the compressed air occupy? My position is this: I have an air engine $3\frac{1}{2} \times 3\frac{1}{2}$ in., which is to be run by an air compressor rated to deliver 90 cu. ft. of free air per min. at 90 lb. pressure and 250 r.p.m. The engine will run at 350 r.p.m. intermittently (about 3 min. with 6 min. rest), but the air compressor will be run continuously. What size reservoir would be necessary so that the pressure would not drop too suddenly? I would like to have the calculations on this, if possible. Also, how many cubic feet of free air does it require to give 1 cu.ft. of air at 90 lb. pressure?"

A. The question at the end of the above is covered by the one at the beginning, so that one answer will cover that part of it. It is generally better to call the normal atmospheric air pressure 14.5 lb. instead of 14.7 lb. as is customary, because we are generally enough above sea level to make this a better average. Then, if the air is compressed to

$$90 \div 14.5 = 104.5 \text{ lb. absolute.}$$

the volume of 1 cu.ft., when compressed, will be

$$14.5 \div 104.5 = 0.1387 \text{ cu. ft.}$$

It is not necessary to consider whether the air is compressed isothermally or adiabatically, or what may be its temperature when it leaves the compressor, as it will certainly lose all its heat before being used and then the above figures will apply.

The compressor is said to be rated at 90 cu. ft. of free air per min. This is taken to be the builders' rating based upon the full piston displacement. If all the inefficiencies are to be allowed for, there must be at least 20 per cent. deducted from the theoretical capacity, which would make the actual free air capacity 72 cu. ft. and the delivery capacity would be

$$72 \times 0.1387 = 9.98 \text{ cu. ft.}$$

or, say, 10 cu. ft. per min. at 90 lb. pressure.

The air consumed by the engine at full pressure, 90 lb., and without cutoff will be

$$3.5^2 \times 0.7854 \times 3.5 \times 2 \times 350$$

$$= 13.64 \text{ cu. ft.}$$

to cover clearance and other losses, making the consumption 17.05 cu.ft. per min., at 90 lb., or

$$17.05 \div 0.1387 = 122.92 \text{ cu. ft.}$$

of free air per min.

As the compressor would run all the time, while the engine would run, according to the statement, only one-third of the time, the compressor delivery to supply the engine should be

$$122.92 \div 3 = 40.97 \text{ cu. ft.}$$

of free air per min. instead of 72, and it would be necessary either to slow down the compressor or to blow off some of the air at the safety valve. If the compressor were slowed down from 250 to 150 r.p.m., the free air capacity per minute would be 250:150::72:43. The 43 cu. ft. would be about right for the case as stated.

The receiver capacity would depend upon the amount of pressure drop that would be permitted, and the question does not tell this. Say that the air receiver has a capacity of 100 cu. ft., and is filled with air at 90 lb. pressure when the engine starts. The total contents would be

$$100 \div 0.1387 = 720.9 \text{ cu. ft.}$$

of free air, say, 721. In three minutes' run of the compressor, it would put into the receiver

$$43 \times 3 = 129 \text{ cu. ft.}$$

of free air, making the total

$$721 + 129 = 850 \text{ cu. ft.}$$

In the run of three minutes, the engine would take out

$$122.9 \times 3 = 368.7 \text{ cu. ft.}$$

of free air, and

$$850 - 368.7 = 481.3 \text{ cu. ft.}$$

of free air, or its equivalent at a higher pressure, remaining in the receiver. Now

$$481.3 \div 100 = 4.81 \text{ cu. ft.}$$

of free air to each cubic foot of receiver content, and 1:4.81::14.5:69.74. The pressure would be 69.74 lb. abs., or 55.24 lb. gage pressure, which would probably be a greater drop than the case would allow.

It is proper to remember that if the engine kept running at a uniform speed, taking out a constant volume of air for each revolution, the pressure drop in the receiver would not be as great as above computed on account of the gradual expansion of the air as the pressure was diminished, but it is evident that it would be enough to defeat the scheme of the installation, and a much larger receiver would be required.

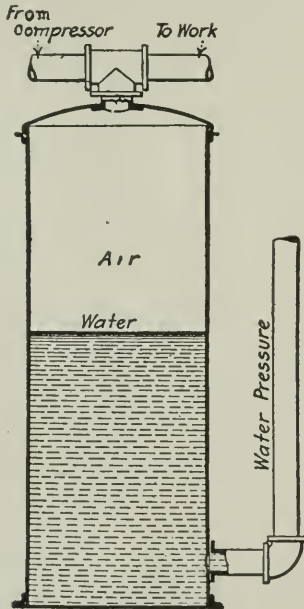
The outcome of the above question is just as unsatisfactory as it always is when dealing

with an air receiver as usually installed. There is no possibility of maintaining a uniform pressure in the receiver if there is any difference in the relative rates of compression and consumption, and as far as power storage service is concerned, the receiver might as well not be.

CONSTANT RECEIVER PRESSURE.

It happens that in most places there is water under pressure which may be piped to the receiver, city water service, water pumped to a tank on the roof or otherwise provided, and this water pressure may be employed to maintain the air pressure constant in the receiver, whether there is little or much air in it, so that the entire contents may be used at the full pressure, even if the compressor is stopped, or it may be used fast or slow within the limits of air supply with perfect satisfaction.

The arrangement is about as simple as anything in the world can be. As shown in the sketch there is a vertical air receiver and near



CONSTANT PRESSURE AIR RECEIVER.

the bottom of it an open pipe connects the interior of the receiver with the water supply, so that the water pressure is always the pressure in the receiver. At the top of the receiver is an air pipe connecting the receiver with the compressor and the air being used is taken away from the same pipe which is in connection with the receiver. No valve or contraption of any kind is required, not even a safety valve,

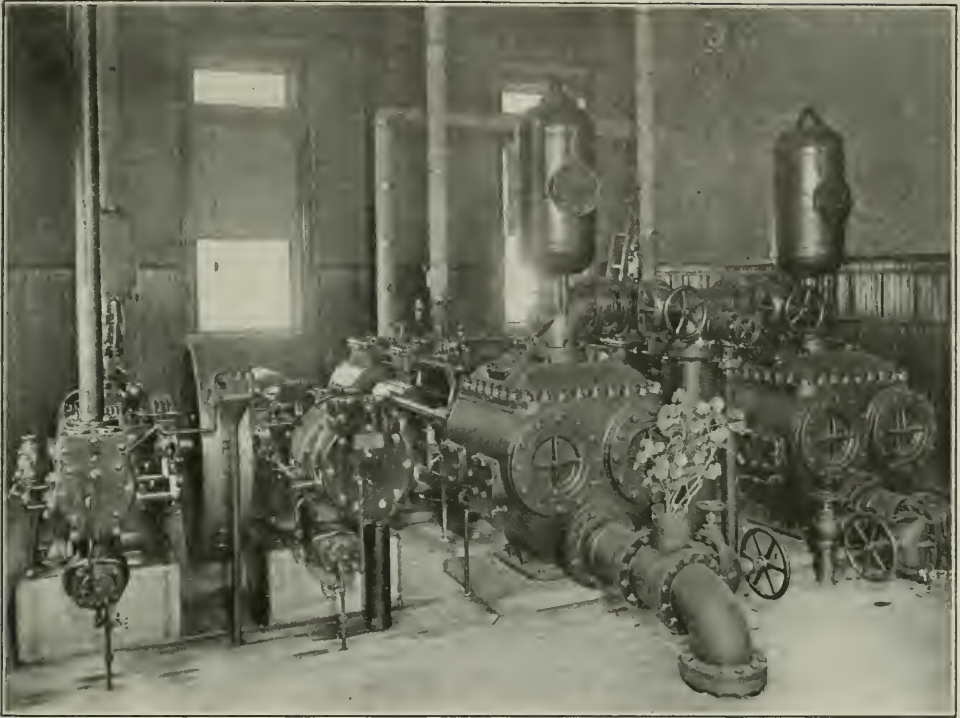
for the pressure can never exceed the constant water pressure.

If the compressor is delivering the air just as fast as it is being used none of it will go into the receiver at all but will pass right along to its work. If the compressor is delivering more air than is being used the excess of air will go into the receiver and drive the water down in the receiver and back to its tank or reservoir. If there is more air being used than the compressor is supplying, the water pressure will drive air from the receiver into the pipes to make up the deficiency; and this it will continue to do until the air is all out and the receiver is full of water. There is not even any waste or consumption of water, as none of it is carried off or escapes. It just plays back and forth between the receiver and the water tank or reservoir.

If there is a reliable water pressure obtainable and if it is not just the pressure desired, this can be varied by locating the receiver upstairs or downstairs, on the roof or in the cellar. Placing it 11 ft. higher will reduce the pressure 5 lb. and putting it 11 ft. lower will increase the pressure the same amount. With this arrangement so generally available, its employment should add much to the value of the air receiver in compressed-air practice. This device was employed in magnificent proportions by Bruno V. Nordberg for the reconstructed hoisting plant of the Anaconda Copper Co., located at Butte, Mont.—*Power*.

OXYGEN SAVED HIM

Ten tanks of oxygen pumped through twenty tons of coal that buried him beneath their weight probably saved the life of Joseph E. Foster, a stoker at League Island. While at work at the navy yard he missed his footing and slipped into the chute, and was immediately plunged into the coal that was burying him alive. Fellow workmen saw him drop and ordered the coal shut off. William Riter, the chief marine hospital steward, ordered an inch pipe to be driven through the coal pile, and this was immediately attached to the compound oxygen tank and the fresh air pumped in, while the rescuers got busy with their shovels. It took exactly 65 minutes to reach the man, and when he was taken from the coal pockets he was unconscious. Artificial resuscitation brought him around.



AIR COMPRESSOR AND STEAM PUMPS, WAUWATOSA, ILL.

CITY OF WAUWATOSA "AIR LIFT" PLANT

The city of Wauwatosa, a suburb of Milwaukee, Wisconsin, derives its water supply from an artesian well having a natural flow at the surface of about seventy-five gallons per minute. Previous to 1911 the water supply was pumped direct from the well into an elevated storage tank, but with the increasing demand the year 1910 found the city without an adequate supply and it was finally decided to secure the necessary increase by use of the "air lift" system of pumping, delivering the water from the well into a surface reservoir and re-pumping from this into the elevated tank.

In June, 1911, an Ingersoll-Rand "Imperial" air compressor, size 8 and 13 and 12 and $7\frac{1}{2} \times 10$, was installed and the well piped for air lift, using a 6 in. water discharge, extending to the depth of 202 ft. 10 in. from surface, and a $1\frac{1}{2}$ in. compressed air line extending to the depth of 190 ft. 9 in. Operating under the above conditions a gauge pressure of 82 pounds per square inch is required to start the flow, which pressure when pumping at the rate of

500 gallons per minute falls to 65 pounds. To deliver this amount of water the compressor runs 120 revolutions per minute, and six hours' pumping per day is sufficient to supply the city at the present time.

With the old system of pumping direct from the well into the elevated tank the coal consumption amounted to 10.8 pounds per 1,000 gallons, and with the air lift, taking our figures from the twelve months of 1912, the amount of coal required for the two operations of pumping the water from the well into the surface reservoir and then re-pumping into the tank was 13.43 pounds per 1,000 gallons, indicating a coal consumption of 2.63 pounds to deliver the water from the well into the storage reservoir, and as the cost of coal delivered at the plant was \$3.25 per ton, this gives a fuel cost of \$.00427 per 1,000 gallons of water pumped, which is certainly a very favorable showing for the "air lift" system.

A large underground river was recently pierced in driving a tunnel through the Cote d'Or Mountains in France and the workmen barely escaped with their lives.

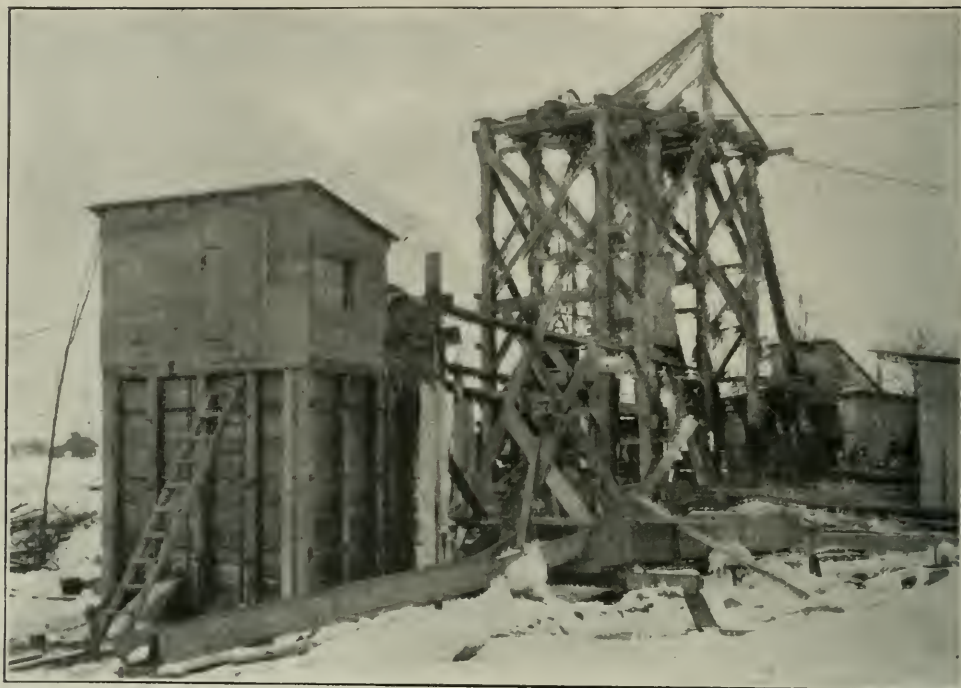


FIG. 1. HEAD HOUSE AND A CAMERON TANDEM SINKING PUMP.

HOW AN UNUSUAL SHAFT SINKING PROBLEM WAS OVERCOME

BY J. J. O'CONNELL.

One of the most difficult shaft sinking problems encountered in the construction of the Catskill Aqueduct was on the Rondout Siphon, extending from Storm King to Rondout.

From the bottom of the shaft on one side of the valley to the shaft on the opposite side is over four miles. This four mile tunnel, however, is not all of the same level, as a change was made near the middle to reduce the amount of difficult excavation. In all, eight shafts were sunk, varying in depth from 375 to 710 feet. No great difficulty was experienced in putting down any of these shafts except No. 4, which is 498 feet deep, and required eighteen months to complete, owing to the presence of large quantities of sulphurous water.

This No. 4 shaft is rectangular in shape, and measures 8x20 feet. It is divided into three compartments. About six weeks after the excavation began there was a sudden inrush of water through a bore hole, estimated at 600 or 800 gallons a minute, flooding the shaft, to

within 40 feet of the surface, but it was successfully pumped out to within a few feet of the bottom. To prevent a repetition of this the bore hole was filled with mortar.

After driving through a thick layer of limestone to a depth of 225 feet, the water came in so rapidly it was necessary to install two more pumps (No. 9 Cameron sinkers). A little later a stream came through one of the bore holes at the bottom of the shaft, which caused the shaft to fill up to within 70 feet of the surface. Again it was pumped dry by the use of an air lift pump and two size 19 and 19x12x16 Cameron Vertical Plunger Sinking Pumps with tandem steam cylinders, located as shown in Fig. 1.

A 2-inch nipple, together with a gate valve, was used to plug the bore hole. The upward pressure of the water was found to be 75 pounds per square inch, indicating that there was a head of 173 feet. To ascertain where the sunken streams of water were, and what quantity of water might be expected, drilling was continued. Unfortunately, water was struck by two holes when one of the pumps was temporarily idle. The second pump was

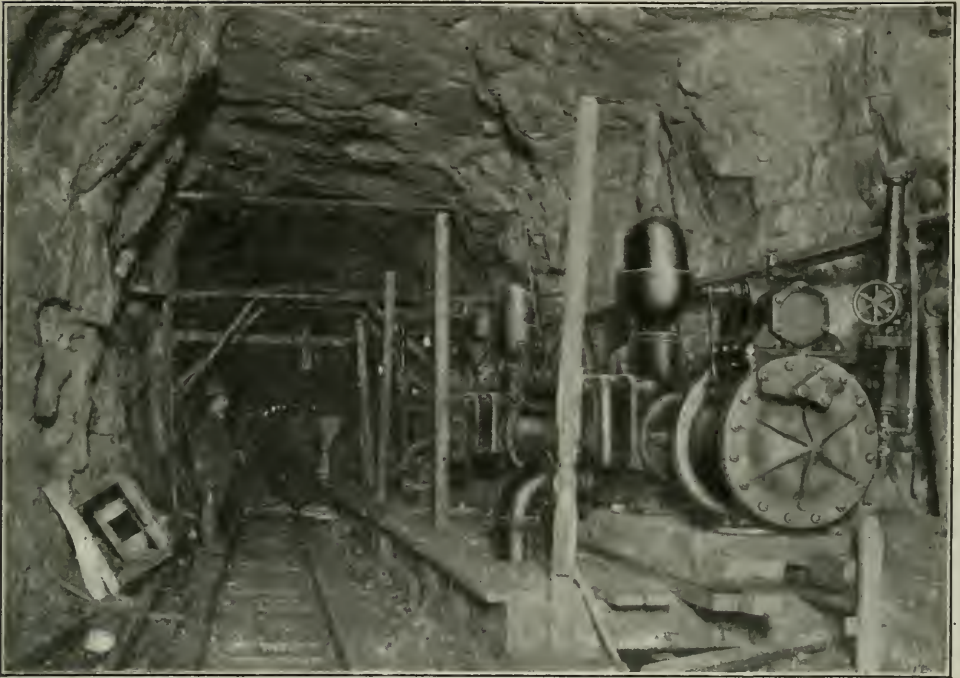


FIG. 2. BATTERY OF CAMERON PUMPS.

now called on for double duty, with the result that the discharge hose broke. The shaft was flooded and the pumps drowned. There was too much water to be handled by the pumping equipment available for prompt service. In fact the conditions were now so severe that in less than two weeks the shaft was flooded on two additional occasions. The bottom of the shaft was now at about the 260 foot level. Sufficient definite information was secured by the drillings, however, to show in some measure what was ahead of the contractor. The recent floodings of the shaft had occurred through 2 inch bore holes, and it was thought advisable to shut off the probable impending water.

It was decided to do this by the use of cement grout, and four grouting machines were installed at the top of the shaft. Difficulty was first experienced from the grout leaking back into the shaft through seams in the bottom and the joints around the pipes. This was overcome by injecting finely ground horse manure with the grout. Eventually the crevices were plugged. As a further precaution additional bore holes were put down; water under a head of nearly 150 feet was found at a depth of 14 feet below the bottom of the shaft, and the grouting process was repeated.

The bottom of the shaft was now in sandstone, but underneath the sandstone was 92 feet of a variety of shale, which it was feared would contain considerable water. To meet this possibility, six diamond drill holes were sunk, and at a depth of 50 feet below the bottom of the shaft water was struck, and when the holes passed the shale cement was injected. The pressure ran as high as 275 pounds per square inch, and 175 bags of cement were required to seal the seams encountered by the holes.

After a lapse of four months excavation was resumed. When a depth of 280 feet had been reached the amount of water coming in from the sides had increased to about 350 gallons per minute. A collection ring was put in at the 265-foot level and the pumps at the bottom of the shaft used this ring as a place of discharge. Two more Cameron Sinking Pumps, size 24x10x16, were used to lift the water from this point to the surface. At 289 feet the second ring was arranged, and a third at 306 feet. When the bottom of the shaft had been put down to 320 feet the conditions were very difficult. As the sinking continued the quantity of water increased, and more pumps were installed, until the shaft was crowded. It was

again flooded for the sixth and as it proved, the last time.

When the shaft had been cleared of water, a large pumping chamber was excavated off to one side at a level of 306 feet below the surface. This chamber was 10 feet high, and had a floor area of 17x24 feet. Beneath the floor a sump 5½ feet deep was dug. This sump was large enough to contain 14,500 gallons of water. In this chamber were installed three Cameron Horizontal Piston Pumps, size 24x12x20, (as shown in Fig. 2), with a combined normal capacity of 1,200 gallons per minute.

The amount of water pumped from this shaft No. 4 was estimated at 86,181,000 foot gallons, and 971 barrels of Portland cement were consumed in the grouting operations.

The work was done by the T. A. Gillespie Co., and the pumps were furnished by the A. S. Cameron Steam Pump Works of New York.

FILTERING AIR

Compressed air that is to be used for aerating the sand or slime, or in agitating the pulp is purified by filtration before use at many cyanide plants. Several types of filters are used; at the Homestake plants the air is pressed through a filter press made up of several cells similar in all respects to the cells of the Merrill presses used in the treatment of slime. Cylinder oil or the products of its combustion or decomposition, which are introduced into the air in the cylinders of the compressors, are the impurities that should be removed as completely as possible before the air is used for agitating. The apparatus at the Alaska Treadwell has a further advantage in that carbonic acid is also removed by caustic soda or milk of lime. The removal of this acid is accompanied by a decrease in the consumption of cyanide, for it is a well known fact that carbonic acid decomposes potassium and sodium cyanides, and even in the presence of an abundance of protective alkali some decomposition by this acid may take place.

On the Witwatersrand 227 air compressors are in use with a total of 103,791 horsepower. Of dynamos, both direct and alternating current, there are on the Rand 232 with a total of 72,016 kw., and in all South African mines, 636 dynamos of 113,767 kw.



FIG. 1. 5 IN. CORES FROM 1,500 FT. HOLE.

CALYX CORE DRILLS FOR CAOL PROSPECTING

BY S. H. PAINTER.

The owners of coal lands who wish to thoroughly prospect their property before going to the expense of opening up mines by driving tunnels or sinking shafts, purchasing and installing machinery and mining equipment, naturally resort to the use of a core drill.

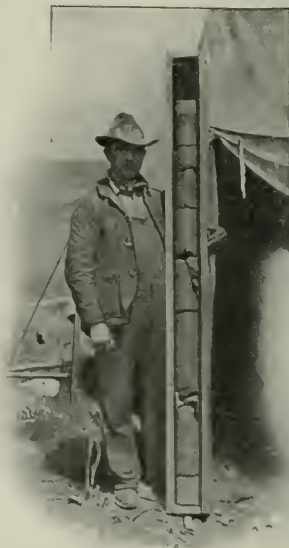


FIG. 2. COAL CORE FROM FIRST HOLE.



FIG. 3. SANDSTONE CORE—COAL CORE IN BOX.

In the earlier days of coal mining in this country, diamond core drills were generally employed, but in recent years the shot drill has come into prominent use. This change is largely due to the advanced cost of carbon for the diamond drill, which makes the work expensive, and necessitates—on account of the cost—the drilling of holes of small diameter, which naturally has a tendency to reduce the possibility of securing perfect cores of the coal vein; while the perfection to which the shot drill has been developed, renders it possible to drill holes sufficiently large to insure good records of the coal rapidly and inexpensively.

Actual information in the way of cost, drilling speed, etc., is often lacking when one not familiar with core drilling attempts to estimate the cost and time required to prove a property; therefore we give the following details of a case in Colorado that is typical of the average coal prospecting job:

The type of drill used was an Ingersoll-Rand Type "BF-1" Calyx, 1,500 feet capacity, equipped with a 38 foot sectional steel derrick, allowing 30 foot sections of rods to be pulled at a time, and 6 inch drilling tools giving cores 5 inch in diameter. Better progress could



FIG. 4. DERRICK WITH STACK OF DRILLS.

have been made if a 58 foot derrick had been used, allowing 50 feet of rods to be pulled at a time, as most all of the holes were deeper than 1,000 feet. The drilling plant was purchased by the Oak Hills Coal Co., who have headquarters in Denver, Colorado. The drilling was done on their extensive coal lands in Routt county, Colorado.

The 'Coal Company, before buying the drill, demanded that it should be guaranteed to drill

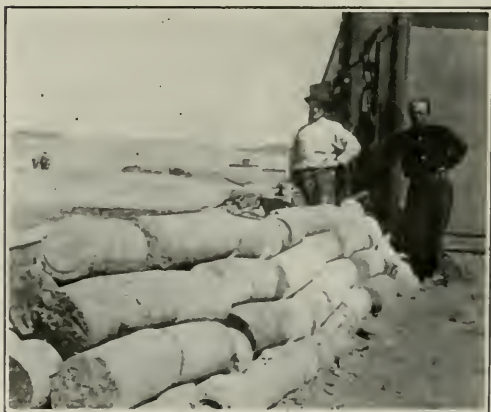


FIG. 5. 18 IN. CORES— WYOMING.



FIG. 6. CORE DROPPING OUT OF BARREL—AFRICA.
the first hole to a depth of 600 feet with 6 inch drilling tools at an average daily progress of not less than 9 feet per nine hour shift, and to produce good cores of the coal. Contrary to their usual custom, the Ingersoll-Rand Company after having one of their experienced drill men look the ground over, accepted the order on those terms. The following is a copy of the drill runner's report on the 600 feet guaranteed test:

RECORD OF BORE HOLE NO 1, OAK HILL COAL CO.,
OAK CREEK, COL.

Type of Drill Used.	BF-1 Calyx.
Depth of hole.....	600 feet
Diameter of hole.....	6 inches
Diameter of core.....	5 inches
Number of 9 hour shifts.....	33
Greatest number of feet drilled in one shift	33
Least number of feet drilled in one shift	12
Average number of feet drilled per shift	18
Formation—Sandstone, slate, shale and limestone.	

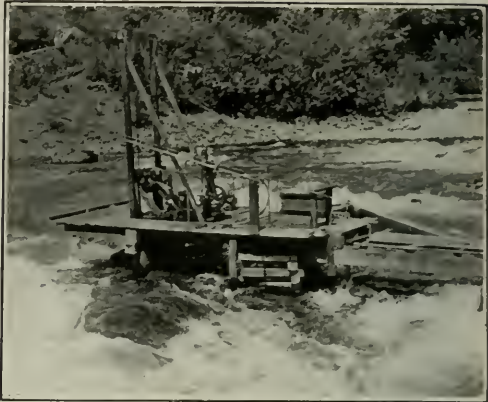


FIG. 7. DRILLING IN BED OF RIVER—OREGON.

Object of drilling—Coal prospecting.
(Three good working seams bored. 100 per cent. of 5 inch core obtained of each seam.)

OPERATING COST.

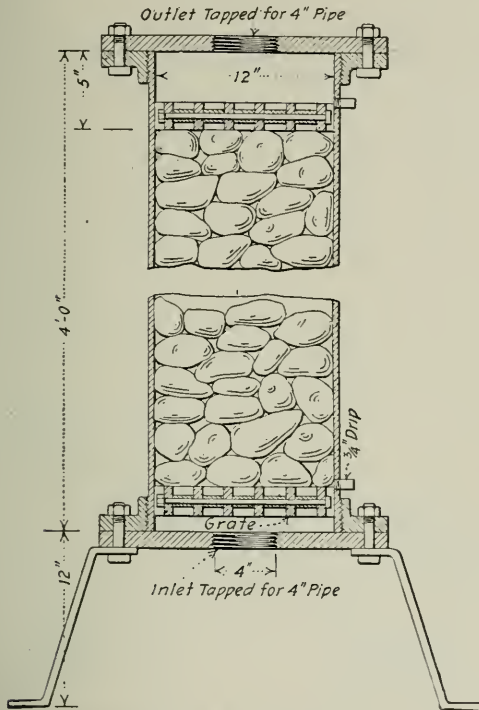
Head driller per shift.....	\$5 00
One helper	3 50
One helper	2 50
Chilled shot per shift.....	15
Shot bit per shift.....	20
Fuel (coal at \$4.50 per ton).....	1 50
Lubricating oil, etc.....	10

Total per shift..... \$12 95
Average cost per foot..... .72
After the guarantee of the first 600 feet had



FIG. 8. DRILLING IN ALPES DE SAVOIE—FRANCE.

been complied with, the coal company continued the hole to a depth of 1250 feet, the progress being a little slower as the hole got deeper, due to the fact that more time was required to remove the core from the hole. A number of other holes have since been drilled ranging in depth from 800 feet to 1500 feet, and in all cases good progress, low operating cost, and splendid records of the coal drilled have been obtained.



COMPRESSED AIR DUST FILTER

BY W. G. HARRIS.

After setting up an air compressor in the vicinity of an ore reducing plant it was found that ore dust was drawn through the compressor into the pipe lines and finally into the pneumatic tools, causing trouble and expense.

After considerable experimenting with various types of screens the following was adopted: A piece of 12-in. pipe, about 4 ft. long, was fitted with cast-iron screwed flanges on both ends. A cast-iron plate, tapped for a 4-in. pipe was bolted to the lower end, also four wrought-iron supporting legs.

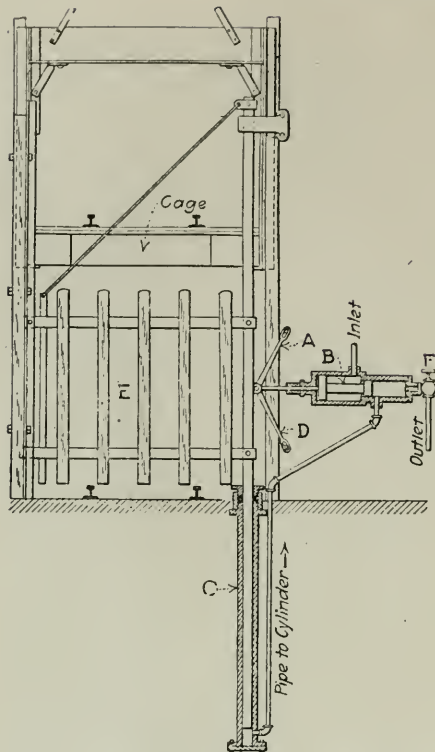
A rough grate, made up of strips of $2 \times \frac{1}{4}$ -in. flat iron with $\frac{3}{4}$ -in. pipe separators $1\frac{1}{2}$ in.

long, and held together with one $\frac{1}{2}$ -in. bolt $11\frac{1}{4}$ in. long, was placed on the bottom. The pipe was filled to within 5 in. of the top with stones about the size of a large orange. The stones were dipped in a thick, sticky refuse oil, which happened to be handy at the time, before they were placed in the pipe. As we figured that in time the oil would work to the bottom, a second grate, similar to the other, was placed on top of the stones so the apparatus could be turned over and used in a reversed position. A flange and gasket similar to that on the bottom was placed on the upper end. Drip cocks were also placed near each end so that any accumulated water might be removed. The line from the compressor was then connected to the bottom flange, by nipples, elbows and flanged unions; the same arrangement was used on the upper end to convey the filtered air to the machines.

Since installing this device two years ago we have cleaned it twice, and on each occasion found that a large amount of dirt, lint, etc., had been collected by the oil, without any reduction in the efficiency of the oil. This same arrangement can be used on the discharge end of all lines if they are of any great length, as all wrought-iron pipe will shed loose scale, especially when first put in service, also after being out of use for some time.—*Power*

A PNEUMATIC POLEAXE FOR THE SLAUGHTER HOUSE

A Poleaxe two and a half inches long, more efficient in cattle slaughtering than its primitive antecedent, is occupying the attention of London butchers. The weapon employed is the council "air-killer." In appearance it looks like a large sky rocket; the rocket end is a chamber charged with compressed air, the stick an elongated valve terminating in a poleaxe only some two and a half inches long. On pressing a trigger the poleaxe is thrown out against the head of the animal, the skull of which it penetrates easily. The animal falls instantly, showing hardly a trace of the hole thus pierced. The "air-killer" has just been adopted by the council as the result of an offer of a £100 prize. It was used upon sheep, calves and bullocks, all of which were, with one exception, killed instantly. It was clear that the efficacy of the instrument depends upon the operator's knowledge of the vital spot in the animal's skull.



AN AUTOMATIC SAFETY MINE GATE

An automatic safety mine gate has recently been invented and patented by M. W. Harvey, of Sykesville, Penn., which, due to its simplicity and ease of manufacture, requires more than a casual notice. It consists of a cylinder approximately $6\frac{1}{2}$ ft. long made of $4\frac{1}{2}$ in. pipe and provided with a stuffing box at the top, inside of which works a plunger made of 4-in. pipe which has been turned down and polished to a diameter of $4\frac{3}{8}$ in. outside.

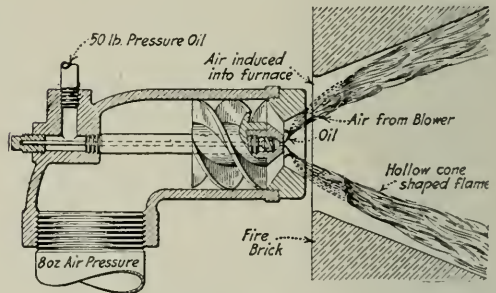
The cylinder is placed vertically in the ground, which renders it frostproof. It may be set at either side of the gate to be operated as convenience may dictate. The gate itself may be made by bending two pieces of strap iron and bolting wood palings vertically between them.

A controlling valve, somewhat similar in principle to a piston valve on a steam engine, is provided. This is equipped with a contact for the cage in its proper position for loading. The outlet, or exhaust, is provided with a throttle valve to control the downward movement of the gate. The general arrangement can be clearly seen in the accompanying drawing.

The operation is as follows: When the cage is brought to position for loading from the ground, it makes contact with the lever *A*, which operates the piston valve *B*. This admits air or steam to the vertical cylinder *C*, forcing up the plunger *D* and with it the gate *E*. When the cage is moved from this position, the piston valve *B* is forced back to its original place by the pressure of the air. This releases the exhaust and allows the plunger and gate to descend. The rapidity of this descent may be controlled by the valve *F* to any desired speed.

In the ordinary operation of hoisting, the contact between the cage and the lever *A* is only momentary while the cage is passing that point. Consequently, the amount of air admitted to the main cylinder is not enough to start the plunger from its initial position, and the gate therefore remains stationary.

This gate can be easily arranged so that temporary removal of one of the guides on the opposite side from the plunger will allow it to be swung open for the loading of long rails or other material upon the cage.



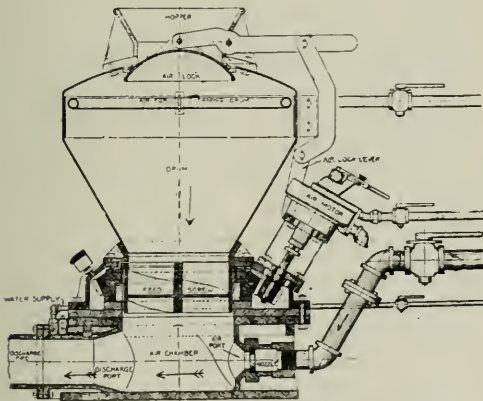
LOW PRESSURE AIR FOR ATOMIZING FUEL OIL

We here reproduce from Engineering News a sketch showing the essential features of a fuel-oil burner designed and recently patented by Mr. H. B. Stolz, 1938 N. Marvim St., Philadelphia.

A characteristic of many low-pressure oil burners has been their ineffective atomization of the oil and a consequent low combustion efficiency. Therefore recourse has usually been made to high-pressure air or steam for atomizing; but the general difficulty which seems to have been encountered here lies in the difficulty of thorough mixture of the oil particles with the proper amount of air, on account of the high velocity of the former.

This design shown comprises an inner nozzle through which oil is forced at 50 lb. pressure. At the end of the passageway in this nozzle is a small orifice and within the passage is placed a spindle bearing a spiral fin, which is claimed to cause the oil on delivery to rotate and spread out in a cone-shaped film. Around the inner nozzle above mentioned is a casing through which air passes, and within this casing is a larger spindle also with a spiral fin, which it is claimed gives the air a whirling motion as it passes out. By the velocity of the air in a radial direction from the burner axis, a certain amount of suction seems to be produced which draws the oil particles into the current of air. This, it is claimed, results in the desired intimate mixture and atomization. The shape of the issuing flame is controlled by the shape of the bell mouth of the outer orifice.

It is reported that competitive tests, conducted in 1912, at the plant of the Link Belt Co. in Nicetown, Pa., showed that this type of burner required only some 31 per cent. of the amount of fuel of high-pressure burners in use. Sizes have been made to give a capacity range of from under 1 gal. of oil per hour to over 400.



PNEUMATIC CONVEYOR FOR CONCRETE

The concrete "blower" as it is called, shown in the accompanying illustration, consists of a hopper and drum super-imposed over an air chamber through which a current of air is passed. The dry materials, mixed or unmixed, are placed in the receiving hopper, and, when ready, dropped as a batch into the drum by opening the dome-shaped air lock. The bot-

tom of the drum is a flat feed screw, or worm, revolved by an air motor. This controls the rate and amount of concrete material fed. As the screw or worm revolves, it feeds the aggregates into the rapidly moving stream of air. Water is fed into the chamber at the same time. The idea in this machine is to take advantage of the velocity of the air to sweep along the material and not use it in any way as a pusher.

The conveyor described is manufactured by the Concrete Blower Co., New York City, and the manufacturers state, should replace hoisting engines, buckets, elevator towers, cars and tracks. The economy of such equipment is especially marked in tunnel construction.

The amount of air required depends on the height and distance to which concrete must be handled. It is planned to build the blowers in five sizes, capacities running from 4 cu. ft. to 40 cu. ft. The manufacturers' specifications state that a pneumatic concrete blower outfit, suitable for placing 100 cu. yds. of concrete in 8 hours, a distance of 500 ft. from the blower, would consist of a blower of 10 cu. ft. capacity; 500 ft. of 6 in. pipe; necessary bends on a 5 ft. radius; an air compressor with a capacity of 500 cu. ft. of free air per min. at 60 lb. pressure, and an air receiver of 200 cu. ft. capacity. With a plant of this description 100 cu. yds. of concrete can be mixed and conveyed a distance of 500 ft. in 8 hours. The labor required to operate this plant, exclusive of the compressor, should consist of four men.

—Cement Age.

HEIGHTS AND DEPTHS

Mount Whitney, the highest point in the United States, is 14,501 feet above sea level, and a point in Death Valley is 276 feet below sea level. These two points, both in California, are less than 90 miles apart. Mount Everest in Asia rises 29,002 feet above sea level, whereas the shores of the Dead Sea are 1,290 feet below sea level, a total difference in land heights of 30,292.

The greatest ocean depth yet found is 32,088 feet, at a point about 40 miles north of the island of Mindanao in the Philippine Islands. The ocean bottom at this point is, therefore, more than 11½ miles lower than the summit of Mount Everest, and the pressure at that depth is about 15,000 pounds to the square inch.

AIR LIFTS DISPLACE CENTRIFUGAL PUMPS

BY W. B. RHODES*.

In February, 1910, a new all-sliming milling plant, on the property of the Compania Minera Jesus Maria y Anexas, at Jan Jose de Gracia, Sinaloa, Mexico, was put into operation. There were installed for the purpose of lifting the tube mill discharges and final all-slime product, centrifugal pumps of a well known make. After six months' running it was found out that this type of pump was absolutely unfitted for this kind of work. Pumps were taken out after a run of 24 hours, others ran a week or two, others for a month. In all cases the shafts and liners were worn in such a manner as to suggest the presence of a mineral similar to emery.

The ore is very deceptive and this is shown by the fact that after passing 20-mesh screens in the batteries, a screen test will show from 48 to 50 per cent. through 200 mesh and 60 per cent. through 150 mesh. The remainder is composed of granules of quartz of a very compact nature. This product was that which caused the final removal of centrifugal pumps and the substitution of air-lifts. Shortly after my arrival here in 1910, I had suggested the immediate substitution of the air-lifts. No serious thought was given the matter, however, until the cost of maintenance, together with the loss of time due to shutting down the mill, not only on account of the sudden wreck of one or two centrifugal pumps, but also on account of rain being blown into the building, which caused the pump belts to fly off.

In October, 1910, the management seeing the folly of continuing with centrifugal pumps, broached the air-lift question to me, and requested that a design to cover the problem be made as quickly as possible. Accordingly two lifts were designed. One was a 2½-inch lift with 65 per cent. submergence, lifting the tube discharge an effective distance of 18 feet. The other lift was a 3½-inch with 54 per cent. submergence, and having an effective lift to discharge launder, of 38 feet. It took about two months to install the air-lifts, as pipes had to be ordered from the United States. It was thought best to have the well-pipes of

generous dimensions, and accordingly, a 3½-inch well-pipe was placed in the lower or tube mill discharge air-lift. In the larger air-lift was placed a 4-inch well-pipe, thus eliminating any unnecessary friction. These pumps to date have been looked at but once since their installation in December, 1910, and the repairs have consisted of two nozzles and an 8-foot length of 2½-inch pipe for the two lifts. The lower or sand air-lift, has plugged up at times, but by closing the inlet or outlet and turning on high pressure air, the obstruction has been easily removed.

The original air pressure as figured was 25 pounds per square inch, but until automatic valves were put in, better results were had at 28 pounds per square inch. The total cost of the new installation, including the sinking of a shaft 5 feet square by 40 feet in depth, pipes, trestles and launders, did not amount to \$300 United States currency. The saving may be summed up as follows:

Maintenance on centrifugal pumps, including cost of pumps, liners, shafts and mechanics' wages, per month	\$200 00
Saving of 20 per cent. in H. P., or 5 H. P., at \$1.25 per 24 hours for 30 days.....	187 50
Saving of 12 hours shutting down per month, equivalent to 40 tons of ore at \$25.....	1,000 00
Total monthly saving.....	1,387 50
Total yearly saving.....	16,650 00

These two air-lifts have been working steadily without interruption for two years and have to their credit at least \$30,000 U. S. currency. Nothing so far has been said about the compressor and its repairs, but as the former was on the property and idle, it has not been charged against the air-lift installation except as to its actual installation in the new power house, and which would not exceed \$150 U. S. currency. The consumption of air varies from 2½ to 3 cubic feet for each cubic foot of sand or slime lifted, depending on the dilution of the pulp. For the final lift of 38 feet a minimum dilution of 5 to 1 is necessary to give good results. The lower or 18-foot sand lift is run on a 3 to 1 dilution to avoid excessive handling of solution.

In conclusion, I wish to say that the difference between smooth running by means of air-lifts and that of having to get out in the middle of the night to repair a broken down

*Superintendent Milling Plant, Cia. Minera Jesus Minera y Anexas, S. A., San Jose de Gracia, Sinaloa, Mexico. From the Colorado School of Mines Magazine, January, 1913.

centrifugal pump, is appreciated here as elsewhere, where others have had similar experiences.

GREATER PURITY OF DEEP-WELL WATER

During the last six years Dr. H. E. Barnard, Chemist of the Indiana State Board of Health, has analyzed about 5,000 well waters. The following we take from a paper by him before the Indiana Sanitary and Water Supply Association.

I am convinced, he says, that of the 2,000,000 wells furnishing water to the citizens of Indiana, at least 1,000,000 are not furnishing pure water, but a water contaminated by the wastes of the home and community. Of 4,959 wells examined in the last few years, 3,051 have been classified as shallow wells, and 1,908 as deep wells. This classification is not perfect, for it is frequently impossible to get data sufficiently adequate to place a well in its proper class. We classify all dug wells as shallow wells, and all driven wells as shallow wells when it is evident that the well does not pass through an impervious stratum. In some parts of the State a layer of clay or hard pan may lie so close to the surface that a driven well not more than 10 ft. deep may, in fact, reach second water, and so entitle it to be classed as a deep well.

In other parts of the State, especially where sand and gravel deposits are deep, a well may be 75 or 100 ft. in depth and still tap only surface water. Obviously, when we do not know all the facts, our classification is subject to some inaccuracies. Nevertheless, it is significant that of the 3,057 shallow wells used as private supplies, but 1,331 were good; that 1,391 were classified as bad and 335 as doubtful. Since a doubtful well water is bound sooner or later to pass the danger line, in the interests of safety it should be viewed with suspicion, and classed with the bad waters. This means that only 43.5 per cent. of the shallow wells are pure. Of the 1,377 deep wells used as private water supplies, 1,091 furnished pure water, 160 bad water and 126 doubtful water. In other words, more than 79 per cent. of all the deep wells furnish a pure water. The difference in the quality of the deep and shallow well is thus strikingly shown. If the actual facts were at hand, I have no doubt but that the proportion of deep wells of satis-

factory character would be greatly increased.

There is no real reason why every properly cased well which passes through an impervious stratum should not furnish pure water, save in the isolated instances where sewage is poured through sink holes or abandoned gas wells into the lower levels. Such conditions do obtain in the cavernous regions in the southern part of the State, and they are not unknown in the so-called gas belt.

Is the time not soon to come in Indiana when the health officer, knowing as he does, that more than 50 per cent. of the surface wells are polluted, will take definite, positive and final steps toward closing them and compelling the community to use the public water supply of guaranteed purity? We are legislating for sanitary school houses where our children are gathered for months of the year. We are going farther than that, we are requiring by law that there shall be no unventilated and unlighted rooms. Is not the next step legislation which will prevent the unwise citizen from quenching his thirst by the effluents of his backyard?

The medical staff of our army recognizes the danger of the well. When a regiment recently made its march from Fort Benjamin Harrison to French Lick, Indiana, and back, the soldiers were under strict orders not to drink from any well along the road. That was official recognition of the danger of the well, and apparently the situation was in the hands of those who could control it. I believe the health officers of our communities have just as great powers as do the officers of the medical corps, if they would only use the courage of their convictions. If it were possible I should say to every health officer in the State, close every surface well in your community. If that is not possible at the present time because a pure public supply is not available, determine by examination at least once each year that every well is potable, and whenever a report is made to you that the water is receiving sewage effluent, close the well. At the time of examination it may still be potable, the solid content may be increasing, the nitrates may be high, but the evidence showing present pollution may be waiting. Remember, however, that any heavy rain may absolutely upset the conditions which have kept the water potable and flush into the well not only the filth from the surface, but debris accumulated in the earth.

WORK DONE BY CALYX CORE DRILLS ON ESTACADA HYDRO-ELECTRIC DEVELOPMENT, RIVER MILL DAM

The growth of the city of Portland and its suburbs has been so rapid, and the demand for light, power and additional railway facilities has increased at such a rate, that the Portland Railway, Light and Power Company have been obliged to augment their sources of power in order to keep in line with the public service demands. The Clackamas Canyon at River Mill, about 32 miles from Portland, is the site of a new power development—a late project of the company—which is said to have cost in the neighborhood of \$1,000,000. We print here extracts from the final report of Frank R. Fisher, engineer in charge, on the grouting of the foundation for the cutoff, with special reference to the use of Calyx Drills.

CHARACTER OF FOUNDATIONS.

The characteristics of the underlying rock were investigated by means of core drilling, pressure testing, and surface examinations of exposed bluffs. In addition, a general knowledge was obtained by observing the material exposed by the excavation for the cut-off and the notch through the island, and also the deep gorge that was disclosed when excavating for the buttress foundations in the right channel. The gorge extending to a depth of forty feet below the bed of the river, offered an excellent opportunity for investigating the character of the rock existing at that depth.

The rock underlying the dam is of volcanic origin, and occurs mainly in the form of lava and ash conglomerate, with embedded boulders and fragments of hard rock of the nature of basalt, varying in size from small particles up to blocks with a principal dimension of several feet. Occurring in the conglomerate mass are isolated pockets, and layers of various other formations, including the so called soapstone, and a certain kind of brittle clay rock, very much seamed, with the joint faces in almost perfect contact. The latter material would permit the seepage of water under sufficient pressure, but would resist the diffusion of grout, and be but slightly benefitted thereby. Its occurrence, however, is so limited in extent, that no apprehension is felt from its presence.

The same may be said of the other heterogeneous materials distributed throughout the

conglomerate mass, and it is principally the latter that had to be considered from the standpoint of stability and permeability, in investigating the foundations for the dam.

The rock mass is traced throughout with seams, very irregular in shape and size, extending in all directions with but slight continuity. They vary from an almost imperceptible cleavage joint up to those having an approximate width of from one to two inches, the large majority observed, measuring but a fraction of an inch. The seams are more or less choked with sand, gravel, small particles of rock, and other debris. No large crevices or faults were found at the site, nor observed in the vicinity of the dam.

On the whole, the rock gives indication of possessing fair bearing value, and while not what would be classed as hard, would probably offer considerable resistance to the erosive action of water, except under high velocities.

ARRANGEMENT OF GROUT HOLES.

On account of the permeable character of the foundations, due to the seamy condition of the rock, as disclosed by the preliminary investigations, it was deemed advisable to grout the foundations, the idea being to accomplish by this method a continuous curtain or cut-off, for a depth of 50 feet under the heel of the dam, across the canyon, and extending up and over the banks, for some distance on either side.

Many experimental tests were made in order to determine the most effective arrangement and spacing of the holes, through which the grout was to be introduced and diffused under pressure. The plan finally adopted contemplated three rows of holes under the heel of the dam, and parallel with the axis thereof. The two outer rows, located six feet apart, were termed the primary lines, and the spacing of the holes thereon was tentatively fixed at six feet. The third line located intermediate between the other two, and called the proving row, was put down after the grouting of the primary holes for the purpose of testing the effect of the grout as regards the tightening of the foundation material. The tentative spacing of the proving holes was also fixed at six feet, staggering with the primaries.

While this layout was generally adhered to throughout the operation, it was found necessary in certain localities to introduce additional



FIG. 1. PANORAMIC VIEW OF DAM UNDER CONSTRUCTION.

holes, when the water pressure tests on the proving holes indicated that further treatment was required. On a portion of the left channel section, where difficulty was experienced in tightening the foundations the final spacing became three feet on the primary rows and two feet on the proving line. Again, on the right channel and up the right bank, a number of holes called for by the tentative layout were omitted, where the pressure tests showed but little seepage. The final arrangement of holes developed as the work progressed, and was programmed in accordance with the varying

conditions of the subsurface material in the different localities, as indicated by the results of the tests.

DRILLING AND GROUTING.

The holes for introducing the grout into the foundation material were put down with Davis Calyx Core Drills. Four were installed early in the work, and later on three more were added, making a total of seven, operating night and day, in ten hour shifts. The whole operation extended over a period of about one year.

The outside diameter of the bit was $2 \frac{7}{16}$



FIG. 2. THE SPILLWAY.

inches, drilling a hole approximately three inches in diameter. In advance of the core drilling, 3-inch wrought iron casing pipes were set to a depth of from five to six feet into the rock and grouted, the upper ends projecting about a foot above the surface, and threaded to permit the attachment of the testing and grouting apparatus. The holes for the casings were put down with a Burley steam drill, using a five-inch bit.

It was the early practice to drill a number of adjoining primary holes before doing any grouting, but this was found to give unsatisfactory results, on account of the free communication existing between the holes. The grout would travel from the one into which it was being introduced, to others communicating with it, with the result that the latter would eventually become choked, without having the benefit of the pressure directly applied to them, as was desired in order to accomplish the widest diffusion of the grout, throughout the material surrounding each hole.

To overcome this, the plan was adopted of distributing the drills over as wide an area as was practicable, and each hole was then tested and grouted immediately upon completion of the drilling, and before putting down any other hole nearby, that might be affected by the communication of the grout. At times, the congested state of the work interfered somewhat with the execution of this plan, but on the whole, it was successfully carried out.

The method usually followed in grouting, was to make connection between the grout tanks and the casing by means of a flexible copper hose, and introduce the grout at the top of the hole, but in order to prevent, if possible, the rapid choking of the hole with cement, which frequently occurred, the method of introducing a pipe into the hole, and discharging the grout at various depths was tried out. For this purpose a 2-inch pipe, made up in sections, was used, and the operation was started with the same inserted to within a few feet of the bottom of the hole. When the hole gave evidence of tightening with the pipe in this position, one section was detached, usually ten feet in length, thus raising the outlet, and the operation repeated. At intervals a charge of water was shot in, to keep the pipe from plugging, and also to loosen up the cement that settled in the hole. This method of grouting through the pipes, was given a thor-

ough trial, but so far as could be observed, it had very little advantage as to the amount of grout the hole would take, over the less laborious operation of introducing it directly at the top. The changing of the position of the pipes also interrupted the continuous flow of the grout, which it was desirable to maintain in order to accomplish the best results.

The consistency of the grout was varied to meet the different conditions, one part of cement to five of water appearing to give the best results, but the proportions tried out varied from 1 cement—2 water to 1 cement—15 water.

The grout was forced in under air pressure ranging from 50 to 200 lbs. per sq. in., depending on the tightness of the hole. While it was desirable to use the higher pressures, in order to accomplish the greatest diffusion, it was not always practicable to do so, on account of it blowing out at the surface.

EQUIPMENT FOR DRILLING AND GROUTING.

The drilling and grouting outfit consisted of six Davis-Calyx Drills (Mfg. by Ingersoll-Rand Co.) Type G. O. and one Davis Calyx Drill, Type G-4. 1,119 ft. of the drilling was done by two steam driven diamond drills. Type B, which were later removed. The Calyx Drills were electric driven by 5 HP. shunt wound D. C. motors, 550V, 8 amp., 1800 R. P. M., belting from 5 inch pulley direct to 12 inch drill pulley on shaft with 12 inch spur gear meshing with 3 inch spur gear, giving drill spindle a speed of 187 R. P. M. 2 7/16 inches outside diameter diagonal slot shot bits cutting a 1 5/8 inch diameter core were used with six foot core barrels of hydraulic 2 inch wrought iron pipe. For soft material, four pointed cutter bits were used with same core barrels. Drill rods were 1 1/2 feet, 5 and 10 feet in length. Drills were equipped with usual accessories, lifters, 24 inch Trimo and Stillson wrenches, water plugs, etc. The wash and shot water used was taken from supply tanks at average head of 97 feet. Labor employed for drilling was white, wages (driller), \$0.30 per hour; helper, \$0.25 per hour for 10 and 12 hour shifts.

The total net cost of drilling and grouting was \$47,770.55, or \$11.40 per lineal foot.

Total net cost for drilling and grouting, allowing for salvage on plant, \$41,861.55, or 1.23 per lineal foot.

Of the total footage drilled, 32,019 lin. ft.

was put down with the Davis Calyx Shot Drills, owned by the P. R. L. & P. Co., and 1,119 lin. ft. by Diamond Drills owned and operated by the Sullivan Machinery Company, working under a cost plus 25 per cent. contract. The holes put down with the diamond drills cost about one-third more per foot than those with the shot drills, on account of the more skilled operators required, in addition to the contract commission.

PROGRESS IN COMPRESSED AIR PRACTICE

The following is an abstract (mostly as prepared by the editor of *Power*) of a paper by George Barr, read before the Manchester Association of Engineers. It will be seen that it refers to English practice entirely, and in some particulars is at variance with American practice, as for instance where the writer says that present day designs of air compressors are mostly vertical.

For pressures from 70 to 100 lb. the compressor is generally two-stage. In a general way the above description covers the major portion of compressed-air plants with piston speeds up to 500 or 600 ft. per min. Valve gears of combined mechanical and automatic type, or of light multiple-ported small-lift types, are employed and clearance spaces are down to 2 or 3 per cent. When in some instances old compressors of the first mentioned design, or somewhat similar, were discarded and a new plant installed, the results obtained easily explain why compressors have for long been considered inefficient. To demonstrate what can be done by installing new machines a case is mentioned where a compressor of four times the capacity of the old machine taken out required only the same amount of steam per hour.

When considering the general question of compressed-air efficiency it is necessary not only to examine the compressor, but the pipe lines and the plant consuming the air must be considered; in this direction there has been great improvement. Taking a wide view of the matter few engineers have given much study to compressed air and have taken for granted that what has been must still continue. Looking at the matter from this standpoint, what is generally found in inquiries issued for large compressors? The capacity of the machine is given; if steam driven, steam

pressure and vacuum are mentioned; if electrically driven, voltage. It is not general that steam consumption is asked, and on rare occasions is a capacity test called for. Such a test when made is seldom, if ever, any check on the output of the machine, the test generally being to fill a reservoir of given capacity from atmospheric pressure to final working pressure. The temperature of the air may be taken or may not, and when taken is generally misleading and possibly allows of error up to 10 per cent. In fact, it is questionable whether there is one compressor at work at the moment, the actual capacity of which is known correctly through a test.

The actual proof that any given machine is really delivering the full amount of air specified is not, of course, sufficient to prove the machine the best possible, as some designs may require more power to compress the air, due to small restricted air passages, poor cooling arrangements, low mechanical efficiency, etc. On the other hand a machine may not have a long life at a high state of efficiency. After all what the user wants is a machine to show small horsepower for air actually delivered, and a figure representing horsepower to compress say, every 100 cu. ft. of air per minute, covers volumetric efficiency, mechanical efficiency, losses in compression, etc.

Taking a reciprocating two-stage air compressor, it will be found that a figure such as 20.5 electrical horsepower is required to compress and deliver every 100 cu. ft. of air up to 100-lb. pressure. Such a figure might reasonably be expected as "covers" for, say, 90 per cent. motor efficiency. For steam-driven machines the indicated horsepower in the steam cylinder per 100 cu. ft. of air compressed as above, should be about 20.

Passing to present designs and bearing in mind the present tendency to install more of such plants in collieries and shipyards, it might not be out of place to give an idea of the general tendencies. First it is found in a general way that colliery units range from about 1,000 to 5,000 cu. ft. and the electrically driven units from 1,000 to 3,000 cu. ft. with unit horsepowers from, say, 200 to 600. These represent plants placed on the bank and power drawn from local power companies' mains. In some quarters there seems to be a tendency to try in the mine smaller semi-portable sets of strong and efficient design, with more attention given to strength and simplicity than was

hitherto the case, when lightness was considered the main necessity.

Comparing overall efficiency of the electrical methods with a large steam-driven compressor on the bank, Mr. Barr gives the following electrical plant assume the current generated losses. In the steam-driven machine the mechanical loss is 10 per cent. and transmission losses, including leakage, 7 per cent. For the at the power house, as it will be found in a general way that the losses in the generation will equal the extra charge for the power as made by the power company. Then there are 10 per cent. mechanical loss in the engine, 10 per cent. loss in the dynamo, 5 per cent. loss in the transmission for the small semi-portable machines and 10 per cent. loss in the motor driving the compressor.

For large motor-driven machines the same allowance of 7 per cent. loss for air transmission must be made as in the steam-driven sets, and for the small semi-portable sets there is a loss of 3 per cent. for the short air piping and leakage. These figures are all relative, but are a fair mean for all the cases. Steam losses therefore equal 17 per cent., large motor sets 37 per cent., and small motor sets 38 per cent., or a difference of 20 and 21 per cent., respectively, representing a margin to cover extra price paid to power companies, or a figure which will make it possible to decide whether extra interest could not be readily paid on the extra capital for the steam-driven sets, together with the difference in running cost and upkeep of both schemes.

Mr. Barr reviewed the changes which have taken place in detail of construction, such as cooling arrangements, governing, lubrication, valve gear, etc. Summarizing he finds with a large installation of four machines of, say, 2,500 cu. ft. capacity each, first, no automatic stopping gear is wanted, as there will be an attendant who can be made use of for any starting or stopping actually wanted over a given day. But if in an electrically driven plant one of the sets had a variable-speed motor to give a desired range when all the plant was in use, this would cover all actual requirements. However, an additional controlling gear arranged to allow so much air to be discharged before compression starts, would give a plant covering all possible fluctuations and assure high efficiency over varying condi-

tions, with the extra advantage of being reasonably cheap.

At the moment automatic valve gears are those most used, and certainly it would appear that the greatest progress has been made in this class. They take the form of a multiple-ported or grid valve with very small lift, the form of valve, fixings and springs being covered more or less by various patents. Should an examination be made of indicator diagrams taken from one of the latest high-speed machines with multiple-ported valves, it would be apparent that the losses due to throttling either on the inlet or discharge are very small and leave little margin for improvement in this direction.

Where it was common to install single-stage machines for pressures of say, 60, 80 and even 100 lb., two-stage compression is now most common. An increase in compressor efficiency of say, 10 to 15 per cent. is obtained in large size units, which also makes for greater reliability due to absence of heating troubles. Further, cooler and drier air in the system can be secured, but it is necessary to have intercoolers of reasonable size, 1 sq. ft. of cooling surface for every 4 cu. ft. of air compressed to 100 lb. not being too large. The intercoolers are also better if placed outside the engine rooms in the atmosphere, say on the shaded side of the building. The cylinder cooling in the best makes of machines may be taken as generally the most efficient possible, as most compressors now have jackets carried entirely around the cylinders and covers.

Referring to the question of reheating, Mr. Barr admits that it would certainly add considerably to the efficiency of a compressed-air installation. In collieries, however, the air is not used at one particular spot; to heat the air immediately after leaving the compressor to, say, 350 deg. F. and then pass it along a distance of perhaps 1,000 ft. is simply wasting money.

With newer designs of machines where piston speeds are higher, more care must be taken of air-cylinder lubrication. In fact, more trouble develops from the use of unsuitable oils in the cylinders than is necessary. The same conditions do not prevail in an air cylinder as in the average steam cylinder, where condensation can always be depended upon to assist towards lubrication. In the air cylinders, although there is moisture in the

air, this will not deposit at the high temperature. In fact, the air cylinders will run very dry and seizures will be the rule if proper care is not taken. For air-cylinder lubrication an oil with high flash point is needed, which will leave little or no deposit, such as high-class gas-engine oil.

These remarks do not refer to compressors other than the usual machines for pneumatic tools and uses requiring similar pressures. For higher pressures machines of three- and four-stages are necessary.

Air compressors can now be had very much higher in efficiency than ten year ago. More care is being taken in the layout of piping systems, and if this betterment were carried into the plant which consumed the air, there would be shown in such places as collieries, results equal to the best electrical schemes. This statement does not suggest that over an instantaneous reading an overall efficiency could be shown with air equal to electricity, but taking a year's comparison with all upkeep charges, running cost and interest on differences in invested capital, or in other words the cost per ton of coal raised averaged over a year, the costs would be much the same. This is the correct test and the efficiency which really matters.

COMPRESSED AIR FOR OIL FORGES IN A NAVY YARD*

The casual observer, walking through any smith shop, will probably be of the opinion that 75 per cent. of the workmen employed therein are loafing. There is a general air of standing around, this condition being caused, of course, by waiting for heats. Time studies on this class of work show what a large percentage of time is lost in this manner, and when it is considered that the smith and his helper, or the heavy forging gang are high-priced day men, the money loss is easily seen to be a high one.

Any method that reduces this waste, materially increases production and decreases cost, and this is the main advantage of oil forges and furnaces.

The smith shop at the Portsmouth Navy Yard, formerly consisted of a heterogeneous collection of coal and gas forges and gas fur-

naces. It is now equipped with 25 open forges, two rivet and bolt furnaces, and three large furnaces, all served by oil. There is also at present one coal forge used for welding stanchions, this being the only class of work for which the oil forge has been found unsuitable.

The oil used is a rather heavy fuel oil with a specific gravity ranging from 0.8755 (30 deg. B.) to 0.9465 (18 deg. B.). It is received in tank cars which are emptied into large storage tanks located underground about 100 yd. from the smith shop on the waterfront. The oil is pumped from these large storage tanks to a small ready-supply tank located in the blower room of the shop, the pump being also located in the same room.

This ready-supply tank has a capacity of 400 gal., and is usually pumped up twice a day so as to insure a sufficient supply of oil at all times during the day to the forges and furnaces. The oil is then forced through a 2-in. main to the burners of the various forges and furnaces of the shop by an air pressure of about 25 lb., which is put on the ready-supply tank from the yard air mains, a suitable reducing valve, of course, being used to secure the step-down in pressure from the yard air mains.

This 25-lb. pressure also performs the required atomization of the oil for combustion. Air for combustion is supplied through a separate pipe (formerly used in the old gas system) to the burners by two large blowers, each having a capacity of 1,200 cu. ft. of free air per minute at a pressure of 5 lb. per in. One of these blowers is operated by being directly connected to a 60-hp., variable-speed, direct-current motor, while the other blower is direct connected to an 85-hp., constant-speed motor. Both motors operate at 220 volts.

The variable-speed motor is capable of taking care of the average load, which consists in supplying air to about 12 open forges and 2 furnaces, and is the motor which is in daily operation. The constant-speed motor blower is provided so that it may be run in case of injury to the variable-speed motor, or in case there is an extra large load on the shop.

It is considered desirable to provide two small units for supplying air for combustion not only for the reason just given, but also because the efficiency of the motors is greater when running under full-load conditions. Both blowers, of course, discharge into the same

*Abstract of article by C. A. Harrington in *American Machinist*.

air lines when both are running, or each running separately.

Complete combustion is secured in the forges with the air pressures above noted. This is readily seen by the absence of smoke in the shop, a condition which immediately appeals to the visitor, and by the absence of any carbon deposit in the forge. No method is provided for heating the oil before delivery to the burner, the system, as designed, not providing for this and the necessity therefor not having yet arisen.

The absence of smoke is an important advantage of oil forges over coal, in that the latter is a very much dirtier installation, not only due to smoke, but also to the small particles of coal and dust thrown into the smith's face by the constant stoking of the coal fire. With oil forges, both the smoke and the necessity for stoking disappear.

It is, of course, impossible to say, owing to the large number of variable factors present, just how much the output of the shop has been increased by the introduction of oil. In forge shops, production is chiefly dependent upon the time occupied in doing useful work, and by taking a sufficient number of careful time studies in both oil and coal forge shops of similar character, say government shops, a close approximation of comparative efficiencies might be obtained.

It is believed, that such an investigation would show a substantially increased efficiency for the oil forge shop, and it can be stated that this increased efficiency is not injurious to the workmen. The installation of oil forges at the Portsmouth Navy Yard has been conspicuous for the absence of any complaints on the part of employees, and not a few have expressed a preference for the oil forge.

The French mushroom industry is located chiefly in Paris and vicinity. This culture is carried on most extensively in subterranean quarries at a depth of 60 to 200 feet from the surface. These quarries have been found extremely profitable in this connection, owing partly to their equable temperature and their freedom from drafts, provision being made, however, for their proper ventilation. They rent for \$30 to \$80 per year, according to the length of their galleries (which sometimes extend over several miles), their height under cover and their ventilation facilities.

ENERGY OF EXPLOSIVES AND
TOUGHNESS OF ROCKS

The percussive or shattering force exerted by different explosives varies greatly, and the propelling force increases in the same ratio as the decrease of percussive force. In blasting, both kinds of work are required from the explosives used, the nature of the rock determining the explosive that should be used.

Among common explosives the following list is arranged in the order of decreasing percussive force and increasing propellent force, viz.:

HIGH PERCUSSIVE FORCE.

- Nitroglycerine,
- Blasting gelatine,
- 65 per cent. dynamite,
- 50 per cent. dynamite.
- 30 per cent. dynamite,
- 40 per cent. ammonia dynamite,
- 40 percent. gelatine dynamite,
- Granular nitroglycerine powder,
- Black powder—fine grained,
- Black powder—coarse grained.

HIGH PROPELLENT FORCE.

The percussive force of an explosive produces the cracks and fissures first required in blasting; but the effect of the blast is not complete without the heaving or propellent force that sets the pieces in motion. The explosive to be chosen for a given work is the one that combines these two forces in the right proportion. An excess of percussive force breaks the rocks too fine and packs the fragments too closely together. An excess of propellent force will throw the pieces too far, with dangerous results.

The following table shows the comparative toughness of some common rocks, as compared with limestone:

Fresh diabase	3.0
Sandstone	2.6
Fresh basalt	2.3
Hornblende granite	2.1
Quartzite	1.9
Feldspathic sandstone	1.7
Calcareous sandstone	1.5
Granite	1.5
Slate	1.2
Dolomite	1.0
Limestone	1.0

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HUMAN DRUDGERY TRANSFORMED

Perhaps in no particular is the progress of the human race more strikingly indicated than in the entire transformation of its primitive and typical drudgeries, the hewing of wood and the drawing of water. In the earlier estate of man no occupations were rated lower, were more constantly exacting or employed so great a proportion of hopeless toilers than those which had to do with the first essentials of his physical existence.

Now is the race not only emancipated from the slavery entailed by its prime necessities, but both the work and the worker have been changed in attitude and status. To-day the hewing of wood, or the providing of fuel, and the drawing, storing and conveying of water for domestic and industrial and agricultural uses engage the highest abilities of the most eminent of the world's engineers. Indeed, the challenge of the primitive occupations has been a principal stimulating and impelling agency in the upbuilding of the engineering profession. Engineering skill now finds its most exacting tasks and its most substantial triumphs in the construction of such works as the Los Angeles and the Catskill aqueducts.

These are spectacular and world famed works, and not only are the successful builders of them to be appreciated and rewarded but the entire mass of men clear to the bottom are benefitted and to be congratulated. Yet besides the great constructions for the water supply of the Metropolis and the larger cities, all the smaller aggregations of humanity now similarly have their respected and valued drawers of water, and in the aggregate their work would measure up well with that which the world so justly boasts of. Under modern methods not only is water provided, as we might say, everywhere in unfailing abundance, but it is also pure and wholesome and health stimulating as was never known before. It is significant of the trend of the times that The Old Oaken Bucket is no longer regarded with respect or affection, and it has taken its place among the things that were, but are no more.

One of the earliest of the devices by which it was attempted to evade the drudgery of water drawing was in the employment of the wind mill for the purpose, and it may be said of it that it brought relief locally and temporarily, but that it was inadequate for the

task as a whole, and its ultimate lot has been to illustrate the picturesque in its decay.

It is a curious thing that in our latest and most advanced methods of water getting we turn again to the atmosphere as our most efficient helper, although the wind mill and the air lift are apparently as far apart as mechanical devices employed for the same purpose could well be imagined. It is not easy to realize all that the air lift has in it for humanity to-day, or the promise that is in it of extended and unlimited service in the future. It has a field of its own in which it is absolutely without a competitor. It gets water in copious flow where no other device could reach it, and it gives water that is above suspicion. It does not work for nothing, neither does it charge excessively, and as things go we may say that it is sure of employment into the far future.

NEW BOOK

The Gas Turbines, Theory, Construction and Records of Results obtained from Two Actual Machines, by Hans Hotzworth, Engineer, translated by A. P. Chalkley, B. Sc. (London), A. M. Inst. C. E., A. I. E. E. J. B. Lippincott Company, Philadelphia. 148 pages, 9 by 6 $\frac{1}{4}$ inches. 142 illustrations and many tables. Price \$2.50.

Messrs. Korting Bros. of Hanover, built the original turbine to the author's designs, and the first turbine employed for actual driving (300 to 800 H. P.) was constructed by Messrs. Brown Boveri & Co. of Boden-Manheim, who also supplied the dynamos and blowing plant. The book represents thorough and conscientious work and embodies data not before obtainable. It should prove of great value to many engineers who need to be informed of the latest developments of the newer types of motors.

CONFIDENTIAL EMPLOYMENT DEPARTMENT

18. Young man who has had extensive experience in English mines with all classes of coal mining machinery. Now located in Canada.

19. Quarry man who has held superintendent's position for years. Also experienced in railroad construction and iron mining.

TAKING A HINT FROM CONTRACTORS' BIDS

W. L. Saunders, president of the Ingersoll-Rand Company, was put in charge of the Bedloe Island channel soon after his graduation from the University of Pennsylvania. This was in 1880. In connection with this work he had some rock excavation to do. Contractors' bids ranged from \$1 to \$40 per yard. The remarkable variation convinced him that they did not know about such work and would be unsafe to rely upon. Rock-drilling was not then the well known art it is now. So Saunders decided to do the job himself on the theory that he knew as much about it as any of the would-be contractors, and could more surely learn what he didn't know. He bought four Ingersoll drills and went to work. This led to an acquaintance with the Ingersoll Company and before long an association with it, which has continued ever since. The company then had five officers and employed 60 men. Now it has 260 officers and 4,000 men. —*Engineering and Mining Journal.*

MEASURING DEVIATIONS OF DIAMOND-DRILL HOLES

BY SIDNEY L. WISE.*

It is not my purpose to discuss the many methods in use for determining the dips and lateral deviations in bore-holes, but simply to give a concise outline of the obstacles encountered and the results obtained in a recent survey of a series of holes. These were drilled at various inclinations in order to intersect the supposed continuation of a lens of pyrrhotite and chalcopryrite, the ore body following closely the foliations of the country rock. The lens dips at an angle of about 66 degrees, and the fact that there is also a pitch to the ore body renders the pointing of the boreholes of considerable importance, to avoid missing the lens.

The country rock may be briefly described as a micaceous and sometimes garnetiferous schist, although the encountering of a hornblende gneiss is by no means rare.

The difficulty encountered in rotating the drill rods was one indication that the holes

*Engineer for the Vermont Copper Co., So. Strafford, Vt.; in Columbia School of Mines Quarterly.

were not straight, and it was therefore decided to survey them. Due to the magnetic properties of pyrrhotite, compass methods were out of the question, but it was decided to determine the variations of dip by the hydrofluoric acid etching method.

For holes of over 600 ft. depth, the regular drill rods were employed to lower the acid bottles into the holes, while for shallower holes a heavy copper wire, mounted on a reel, was used for the lowering. The etching agent was a mixture of concentrated hydrofluoric acid and water. For shallow holes, one part of acid to two parts of water were used, but for deep holes one part of acid to four parts of water were employed. In the former case, 20 minutes were allowed for etching, whereas it required 70 minutes to procure a clear etching when using the weaker mixture.

The etching solution was placed in a bottle of the kind used for homeopathic medicines. This bottle was selected because of its uniform interior and exterior diameters, and because of its strength. The bottles were corked very tightly by rubber stoppers, and then were placed in cylindrical steel containers of the following general design:

Each container is made in two parts, which have respectively a male and female thread. This threading is very close, and rubber gaskets are used to prevent water from leaking into the container. Trouble was experienced from this cause, due to the great hydraulic head to which a container is subjected when down 600 ft. or more. The inside of the container is cylindrical and is just large enough to contain the bottle. If water leaks into the container the pressure may be great enough to break the glass bottle inside. On the outside of each end of the container is a thread, which can be screwed into the drilling rods. The outside diameter is the same as that of the rods used, which insures that the container will lie in the true course of the hole. The length of the container, including threaded ends, is 1 ft. By placing containers between rods, at intervals, etchings were taken simultaneously at four successive 100-ft. spaces. The etching appears as a thin translucent line on the inside of the bottle.

Previous experience has shown that the angle obtained by reading the etching is not the true angle of the hole at the corresponding point. Capillary attraction causes the liquid

to climb up higher on the upper side of the bottle than on the lower side. This causes the etched line to indicate a steeper dip than the actual and hence a negative correction is necessary for every reading. Laboratory experiments show that the capillary attraction varies with the dip of the bottle. They further show that the maximum attraction takes place at about 45 degrees, with a constant increase in the necessary correction from 0 degrees to 45 degrees, and a constant decrease from 45 degrees to 90 degrees. The correction when the bottle is inclined at 45 degrees is about 8 degrees. The capillary attraction also varies with the strength of the solution as well as with the diameter of the bottle, and it is therefore necessary to make the laboratory test under conditions as close as possible to those occurring in actual surveying.

The following results of a survey of one of the holes may be of interest, as it shows a remarkable flattening of the hole during diamond drilling, using the customary, rigid, steel rods:

Depth in feet.	Corrected dip of hole.	Depth in feet.	Corrected dip of hole.
100.....	56° 40'	600.....	32° 20'
200.....	53 40	700.....	31 15
300.....	49 45	800.....	29 15
400.....	41 50	900.....	20 30
500.....	36 50	1,000.....	26 40

This hole was started with a dip of 61 degrees 30 minutes and it is interesting to note that a depth of 1,000 ft. the hole was inclined only 26 degrees 40 minutes with the horizontal.

THE WATER WE "CONSUME"

Each individual drinks in course of a year about one ton of water, but this is only a small fraction of what you use for the support of the human machine. In the course of a twelvemonth you eat the equivalent of two hundred pounds of bread and two hundred pounds of meat, that is to say, four hundred pounds of food. But the bread and meat must themselves be produced directly or indirectly from the soil, and this can be accomplished only by large expenditure of water. Plants will not grow without water. To produce the grain necessary for making two hundred pounds of bread at least four hundred tons of water are required. Thus we begin to get a notion of the really enormous indirect consumption of water by the individual human

being. He cannot get along without it. If a man was reduced to an allowance of say one thousand tons of water a year he would soon die.

"OXYBENZ" WELDING

Autogenous welding in which the usual acetylene is replaced by any of the lighter hydrocarbons seems to have advanced beyond the experimental stage in some of the European countries and is now being advocated and practiced by at least one company in England. The chemical composition of the lighter hydrocarbons, such as benzol or petrol, is very similar to that of acetylene, and it is claimed that after vaporization and burning with oxygen nearly as high a temperature is produced as with acetylene. The chief claim for this system is economy in installation and low cost of working. It has a further advantage that it is extremely portable, and fuel for working it can be obtained in all civilized countries, for oxygen is used wherever the medical profession is represented, and petrol, benzine, benzol or any of the other hydrocarbons can be used with it. The limitations of the process are found in the fact that the flame temperature is not quite as high as with acetylene, and in consequence welding by this method takes somewhat longer. For thin sheet metal work this time is not of much value, but in welding heavier material heat is transmitted from the part to be welded to the body of the metal, thus making it rather uneconomical, as the reduced cost of fuel is more than balanced by the additional time taken by the operator, who must be highly skilled, and consequently well paid. This very fact points to an advantage in dealing with work which is liable to distortion if heated intensely in one spot, because the fact of it taking longer to achieve welding temperature will allow a bigger body of metal to become heated to a temperature more near that of the part being welded.

In cutting by this method, where cheap labor can be utilized, the additional time is very much more than balanced by the lower cost of the liquid fuel, and where machine cutting is in vogue the saving is considerable. The usual oxygen bottle is used and the same pressure regulator, but a pipe is carried to a steel bottle somewhat similar in construction to the well-known laboratory wash-bottle, the pressure on

the surface of the liquid being obtained from the oxygen cylinder, so forcing the fuel along a tube to the blow-pipe. The benzol bottle is fitted with a safety device.

A minor advantage possessed by the "oxy-benz" method is that the pipe carrying the oxygen and the liquid to the blow-pipe is of very neat construction; furthermore, it is much lighter than those used for the oxy-acetylene method. A rubber tube is used to carry the oxygen and is surrounded by a thin flexible tube which carries the benzol and practically armours the inner rubber tube. A bye-pass is arranged at the nozzle of the blow-pipe to keep the end hot, so as to vaporize the benzol when it reaches there. The one disadvantage this system possesses is that the end of the blow-pipe has to be heated by an outside flame before the fuel will evaporize and mix with the oxygen to form the proper ignitable compound. In the standard set supplied by the company the blow-pipe is fitted with nine interchangeable tips to make it suitable for work of various dimensions, the whole outfit comparing favorably in price with a high pressure dissolved acetylene system to which its capabilities are most closely allied.

NOTES

Granite is two and two-thirds times as heavy as water; its specific gravity is 2.663. A cubic yard of granite weighs exactly three-quarters of a ton. The strength of granite is tremendous, although the different granites vary greatly. Poor granites will withstand a pressure of 18,000 pounds to the square inch. Good, close-grained granite will withstand 30,000 pounds; but certain Wisconsin granites have withstood a crushing pressure of 43,973 pounds to the square inch—twenty-two tons weight resting on a tiny cube of stone not much larger than a lump of sugar.

The development of the metallurgical industry in Belgium has been such that that country is now the largest *per capita* consumer of pig iron in the world, using annually 738.5 lb. of pig iron per inhabitant, while the United States comes second with 650.4 lb. Next in order of importance are Germany with 482.2 lb., England with 447.5 lb., and France with 242.5 lb. As regards steel, Belgium occupies second place with an annual consumption of 418.9 lb. per head of the population, as com-

pared with the United States consumption of 617.3 lb. per head. Germany follows Belgium with 396.8 lb., England comes next with 308.6 lb., and then France with 196.2 lb.

A demonstration has been given at Southport, in England, of a vacuum street sweeper brought out by a Sheffield firm. The machine, which is the invention of an Italian engineer, resembles an ordinary automobile, and is fitted with an apparatus producing a suction effect. It is claimed that the machine will sweep a road or street without raising any dust and without causing any damage to the surface.

The bubble of a good carpenter's level indicates variations of level in the ratio of four to one to the foot. Thus in a length of one foot a change from level of $\frac{1}{64}$ inch should change the position of the bubble in the glass $\frac{1}{16}$ inch. The highest grade precision levels magnify variations from a level plane thirty-two times. Hence a precision level one foot long should indicate a change of height of 0.0001 inch at one end by a bubble movement of 0.032 inch, an amount easily seen with the naked eye.

When you are afraid that some one will find out what you are doing, and especially how you are doing it, take this verse of Kipling's for a bracer:

"They copied all they could follow,
But they couldn't copy my mind,
And I left 'em swearing and stealing
A year and a half behind."

There is nothing to fear in a stern-chase of shop ideas.

A quick job of cutting up steel building wreckage was recently done in Baltimore. The building was destroyed by fire and the frame was a mass of buckled and twisted members, largely 10-in. steel channels. The plant used was a No. 3-T oxyacetylene welding and cutting plant manufactured by the Alexander Milburn Company. It was mounted on a truck to facilitate moving, and 50-ft. lengths of hose were employed, thus giving a considerable range for each position of the truck. By its use one operator and helper with a single torch were enabled to cut up iron into movable lengths faster than a force of five

men could load it on rail trucks and take it away.

One of the clever wrinkles for saving labor on the automobile is an impulse air pump which can be applied to any one of the cylinders in place of the spark plug and used for pumping up the tires. The device consists essentially of a small differential piston working in a cylinder fitted with suitable valves. It is operated by running the engine with three or five cylinders, the cylinder to which the pump is connected being dead, of course, because the spark plug is removed. The air compressed in the cylinder is driven through the pipe connecting with the differential piston and drives it upward. The small piston connected to the larger piston compresses a small charge of air to a higher pressure and forces it into the tire. The residual air remaining in the small cylinder "kicks" the differential piston down as the engine cylinder makes its down stroke, the momentum being sufficient to complete the stroke and draw in a fresh charge of air.

The administration of the Russian railways is seriously occupied with the project of a tunnel of gigantic proportions through the Caucasus Mountains. This tunnel, the largest in the world, would have a length of nearly 16½ miles, and it has been already the object of a conference between Russia and foreign engineers, who have found: 1. That the geological structure of the mountain does not present any great obstacles. 2. That during the borings of the galleries no such difficulties will be encountered as during the borings of the Simplon tunnel. 3. That the temperature can be maintained at about 77 degrees Fahr. 4. That the elevation of the tunnel being between 4,300 and 4,650 feet, there is no danger of encountering subterranean water courses. 5. The work will take about eight years. This great undertaking would insure a direct connection between Vladikavkees and Tiflis.

Austria-Hungary is the fourth largest coal producing country in the world, although three states of the United States are much larger producers. In 1910, Austria-Hungary mined 53,600,000 tons of coal, which was less than one-fourth of Pennsylvania's production for 1911, whereas West Virginia produced nearly 60,000,000 and Illinois 53,683,000 tons.

A seven-foot vein of the finest anthracite coal has been uncovered recently by some rock-men of the Philadelphia & Reading Coal & Iron Company, while they were engaged in driving a tunnel at the Bear Valley shaft.

Increase in temperature with depth is a common phenomenon. It is usual to assume an increase of 1 degree F. for each 65 ft. of depth, but the actual increase is variable. Recorded figures are, 1 degree F. for each 33 ft. on the Comstock lode; 208 ft., on the Rand; 77 ft. at Bendigo; 80 ft. at Ballarat; 43.5 ft. in the Thames field, New Zealand; 32.8 ft. at Waihi.

Utah is unique among the United States in the diversity of its production of precious and semi-precious metals. It does not rank first in the production of any of these metals, but it stands well among the leaders in the production of gold, silver, copper, lead, zinc, and vanadium minerals. In the production of lead and silver it ranks third; fourth in copper; sixth in gold, and seventh in zinc.

Safety on the oil-burning ships in the Navy will be increased by the provision, on such ships, of an oxygen breathing apparatus. It is estimated that about 10 lives are lost each year on these oil-burning vessels, when men are overcome by gases escaping from the liquid fuel. The apparatus is simple, consisting merely of a small oxygen tank, a flexible tube, and a mouth piece covering the nose and mouth, but not hindering the vision as the usual helmet does.

In Germany ozone is used in connection with the ordinary processes of refrigeration. In the cold storage rooms attached to slaughter houses the temperature of the air is liable to be raised to a serious extent when the doors are left open for any reason; for instance, when meat is being put in or taken out. The micro-organisms of putrefaction immediately become active under such circumstances and the keeping quality of the meat is diminished. If the air of the cold storage room is ozonized, its temperature may be raised without injury to the contents.

As compared with the 38 feet per second, which is considered the limit in safe speed for a cast-iron flywheel, some of the peripheral

speeds attained by the disks of steam turbines are striking. The highest peripheral speed which it is possible to employ is probably found in the 300-horsepower DeLaval turbine, in which with a 30-inch wheel running at 10,000 revolutions per minute, a velocity of over 1,300 feet per second is reached.

In drilling and blasting the Culebra Cut, both piston and churn drills have been used. The usual depth of hole, has been about 27 ft. the holes being spaced 14 ft. apart. They are loaded with 45 per cent. potassium-nitrate dynamite and fired by an electric current from a lighting circuit. About 2¼ cu. yd. of material is obtained per pound of powder. The explosive used is what is commonly called "straight dynamite," having a high velocity of detonation and good water-resisting qualities, but generating more noxious fumes than the gelatin or ammonia dynamites.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MARCH 4.

- 1,054,728. POWER DEVICE. MORRIS C. WHITE and OTHO C. DUREA, Chicago, Ill.
- 1,054,754. FLUID-PRESSURE MOTOR. CLARENCE A. DAWLEY, Plainfield, N. J.
- 1,054,760. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. RUFUS B. FOWLER, Worcester, Mass.
- 1,054,765. DEHYDRATING APPARATUS. GORDEN DON HARRIS, Bay Shore, and JAMES S. POLLARD, Mamaroneck, N. Y.
- 1,054,775. SAND-BLAST APPARATUS. FOSTER J. HULL, Brooklyn, N. Y.
- 1,054,789. DIE-CASTING MACHINE. LATTON M. PARKHURST, Indianapolis, Ind.
1. A die casting machine including a crucible, a conduit from the lower part thereof through which the metal may be forced to a die, means for supplying heat to the crucible, and means for applying products of combustion under pressure upon the metal in the crucible for forcing the same out through said tube.
- 1,054,807. AERATING-CHURN. WILLIAM S. H. WAILES, Pecos, Tex.
- 1,054,832. PNEUMATICALLY-PADDED BOXING-GLOVE. ALFRED DUNN, Philadelphia, Pa.
- 1,054,866. AIR-PUMP. CHARLES J. PILLING, Philadelphia, Pa.
- 1,054,947. ROTARY FAN OR BLOWER. FREDERICK R. STILL, Detroit, Mich.
- 1,055,004. AIR-PUMP. FRANK H. WALKER, Laporte, Ind.
- 1,055,161. FLUID-PRESSURE-OPERATED VALVE. HARRY G. GEISSINGER, New York, N. Y.
- 1,055,196. AIR-COOLER FOR AIR-COMPRESSORS. HARRY EDWIN MACCAMY, Spokane, Wash.
- 1,055,210. AIR-EJECTOR. DONALD BARNES MORISON, Hartlepool, England.
- 1,055,239. COMPRESSOR. JOHANN STUMPF, Berlin, Germany.

- 1,055,250. PUMPING MECHANISM FOR VACUUM-CLEANERS. VICTOR WINQUIST, Rockford, Ill.

MARCH 11.

- 1,055,308. FAN OR FAN-BLOWER. ISRAEL BENJAMINS, New York, N. Y.

1. In a fan or fan-blower two or more rotary units, each comprising a set of vanes and a set of steam turbine blades, said units being adapted to rotate in opposite directions in alternate order and to propel the air in substantially the same direction.

- 1,055,332. GAS-ENGINE STARTER. STEPHEN S. KRAYE, St. Louis, Mo.

- 1,055,343. APPARATUS FOR CASTING. FRED LLOYD MARK, Chicago, Ill.

2. In combination, a flask, vacuum producing means connected with said flask, a mass of porous material having a cavity therein disposed in said flask, and a layer of material of greater density associated with said porous mass in position to separate the vacuum producing means

- 1,055,605. PNEUMATIC PLAYER-ACTION. DAVID REDDIE CARSON and GAVIN WALLACE RUSSELL, Ottawa, Ontario, Canada.

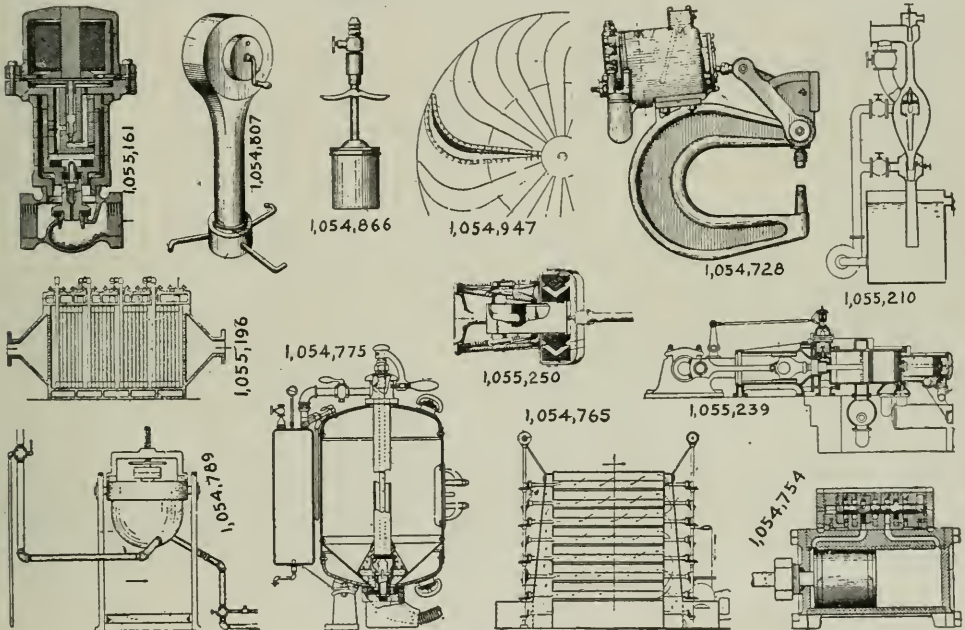
- 1,055,611. CONVERTIBLE ENGINE AND COMPRESSOR. JOHN S. CLARKE, East Cleveland, Ohio.

- 1,055,661. COMPRESSOR FOR ICE-MAKING APPARATUS. CHARLES A. SANQUIST, St. Louis, Mo.

- 1,055,710. VACUUM-JACKETED RECEPTACLE. ANTHONY J. CONROY and JOHN T. SULLIVAN, New York, N. Y.

- 1,055,769. ENGINE-STARTING MECHANISM. CARL E. LIPMAN, Beloit, Wis.

1. In combination, a chambered casing having an exhaust passage, means for forcing air through the chamber of the casing to the said exhaust passage, a spray nozzle delivering to the chamber of the casing, an explosive motor exhausting into the chamber of the casing and having a water jacket and a pump delivering to the said spray nozzle through the water jacket of the motor.



PNEUMATIC PATENTS MARCH 4.

from the atmosphere, there being a sprue through said porous mass and said denser layer to said cavity.

- 1,055,373. UNIFORM-RELEASE TRIPLE-VALVE DEVICE. WALTER V. TURNER, Edgewood, Pa.

- 1,055,411. OIL-BURNER. CLOYD C. MCWILLIAMS and JOSEPH MILLER, Schenectady, N. Y.

3. In an oil-burner, a casing beveled inwardly at its outer end, means for conducting fluid fuel and fluid under pressure to the inner end of the casing, a rotary member mounted within said inner end of said casing and movable in response to entering fluids and a mixer connected to and movable by said rotary member and comprising a conical portion fitting within said beveled end and provided with a series of blades against which the fluids are directed.

- 1,055,444. PNEUMATIC SLACK-ADJUSTER. CHRISTOPHER P. CASS, Maplewood, Mo.

- 1,055,557. PNEUMATIC POWER-TRANSMISSION MECHANISM. FRANK M. PRATHER, Los Angeles, Cal.

- 1,055,734. AIR-CUSHION DEVICE FOR VEHICLES. JOHN G. FUNK, Swissvale borough, Pa.

- 1,055,844. PRESSURE-DRIVEN DRILL. ALPHONS L. WESTRICH, Salt Lake City, Utah.

- 1,055,845. MINE-LOCOMOTIVE. WILLIAM C. WHITCOMB, Rochelle, Ill.

- 1,055,857. PROCESS OF OPERATING PERCUSSIVE APPARATUS. HANS CHARLES BEHR, Johannesburg, Transvaal.

1. In a percussive apparatus, the process of delivering an uncushioned blow, which consists in forcing forward against a constant pressure a piston by means of a fluid under a varying pressure adapted to fall to a predetermined point; and in preventing said varying pressure from falling below said point while actuating said piston, substantially as described.

MARCH 18.

- 1,056,011. SMOKE-CONSUMER AND FUME-ARRESTER. JOHN J. DE MONT, Bayonne, N. J.

2. In an apparatus for the purpose set forth, the combination of a receiving tank, flues entering the same to supply smoke and fumes thereto, a gas collecting tank communicating with the receiving tank, gas outlet tubes in the said collecting tank, and an air blast pipe equipped with nozzles disposed concentrically within but spaced from the ends of said gas outlet tubes.

1,056,033. PNEUMATIC CLEANER. JOSEPH KUBOSCH, Milwaukee, Wis.

1,056,170. STROKE-SHORTENING DEVICE FOR PERCUSSIVE TOOLS. CHARLES C. HANSEN, Easton, Pa.

1,056,244. PROCESS OF EXTRACTING NITROGEN FROM AIR. EDWARD M. WILEY, Adams, Ind.

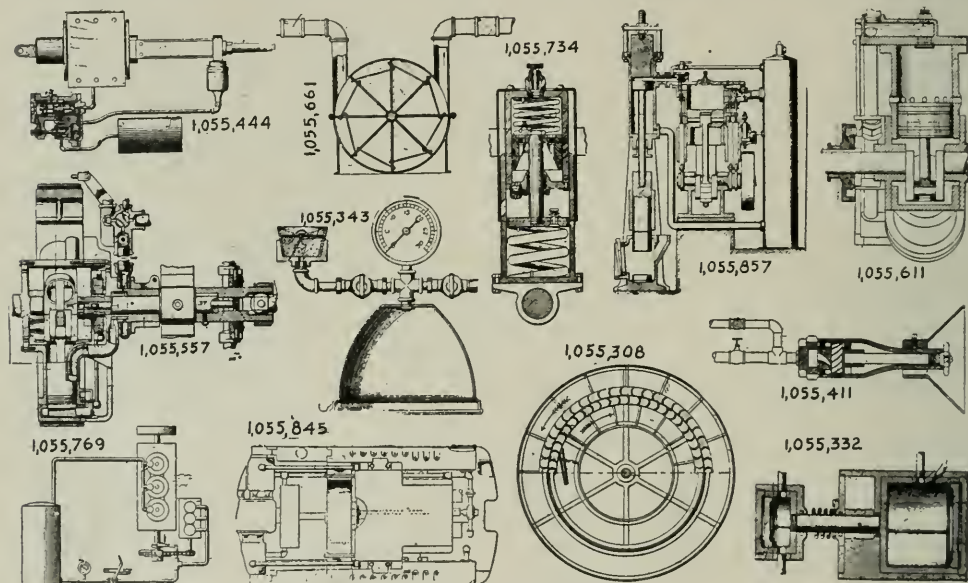
1. The herein described method of reducing the proportion of nitrogen to oxygen in air, consisting in directing air under pressure into a high pressure tank, setting up a circulation of water through said tank to saturate the water with oxygen and nitrogen, directing the saturated water into a low pressure tank to separate the oxygen and nitrogen therefrom, with-

1,056,688. CENTRIFUGAL APPARATUS FOR PUMPING AIR OR GAS. WALTER KIESER, Berlin, Germany.

1,056,689. ROTARY COMPRESSOR. WALTER KIESER, Charlottenburg, Germany.

1,056,709. PUMP. HENRY J. POLLACEK and WILLIAM E. POLLACEK, New York, N. Y.

A sewage-level control system comprising a sewage tank having valve controlled intake and discharge pipes, a compressed air reservoir, a valve casing having two communicating chambers, one of which is connected with said sewage tank and the other of which is connected with said compressed air reservoir, a second valve casing having two communicating chambers one of which is connected with said sewage tank and the other of which is open to the outer air, valves arranged in said valve casings and controlling the communication between the chambers therein, a valve stem common to and carrying said valves, said valves being so arranged that when the opening between the chambers in one casing is closed, the chambers in the other casing are in communication, a solenoid provided with



PNEUMATIC PATENTS MARCH 11.

drawing the gases from the low pressure tank and directing them under pressure into a second high pressure tank, directing a current of water through said tank and through a low pressure tank to produce a mixture having a smaller proportion of nitrogen to oxygen and directing overflow gas from said second high pressure tank back to the first high pressure tank, and utilizing the overflow from the first high pressure tank for actuating the air and water forcing means.

1,056,250-1. VALVE FOR PERCUSSIVE TOOLS. LEWIS C. BAYLES, Easton, Pa.

1,056,288. ROTARY BLOWER. NEIL W. MACINTOSH, New York, N. Y.

1,056,426. PNEUMATIC SOLE FOR SHOES AND BOOTS. JOHN P. KENNY, Rochester, N. Y.

1,056,506. AIR-HOSE COUPLING AND UNCOUPLING TOOL. CHARLES L. COURSON, Pitsburgh, Pa.

1,056,511. AIR-COMPRESSING APPARATUS. JOHN DESMOND, Wilmette, Ill.

1,056,513. METER FOR MEASURING ELASTIC FLUIDS. AUSTIN R. DODGE, Schenectady, N. Y.

a plunger, a lever connecting said plunger and valve stem, a float resting on the surface of the sewage in said sewage tank, and means operated by said float for controlling the current through said solenoid and thereby alternately connecting said sewage tank with said compressed air reservoir and the outer air.

MARCH 25.

1,056,782. WHISTLE. HORACE ELLISON, Lynn, Mass.

1,056,789. APPARATUS FOR PRODUCING OZONE. SIEGFRIED HELD, Chicago, Ill.

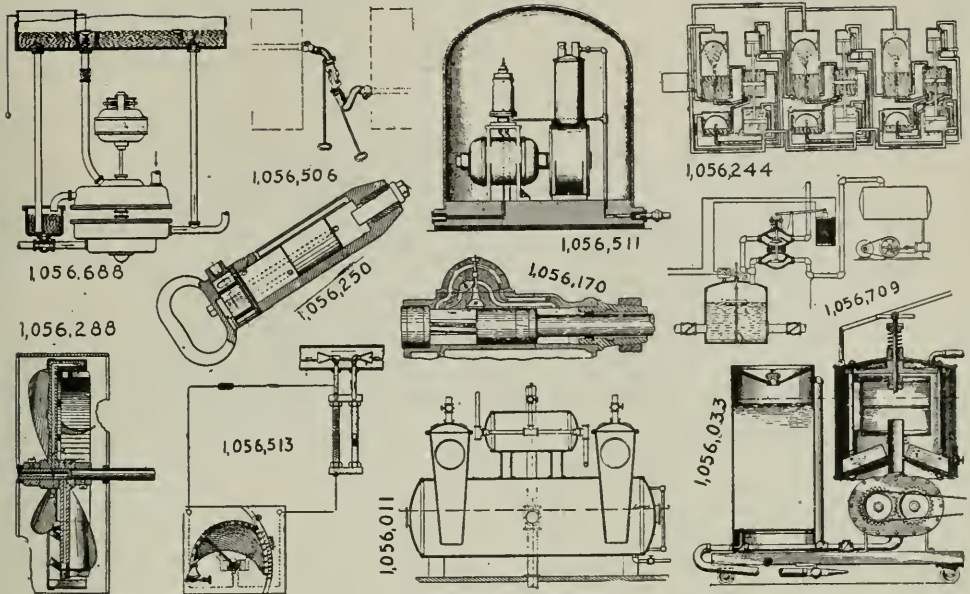
1,056,813. FAN-BLOWER. EMBURY MCLEAN, New York, N. Y.

1,056,859. COMPRESSION AND SUCTION MACHINE. JAMES B. VERNON, Pittsburgh, Pa.

1,056,865. SUCTION-PRODUCING APPARATUS. GEORGE WEBSTER, Christiana, Pa.

1,056,929. AMUSEMENT DEVICE. LEON DE VARGAS NAVARRO, Los Angeles, Cal.

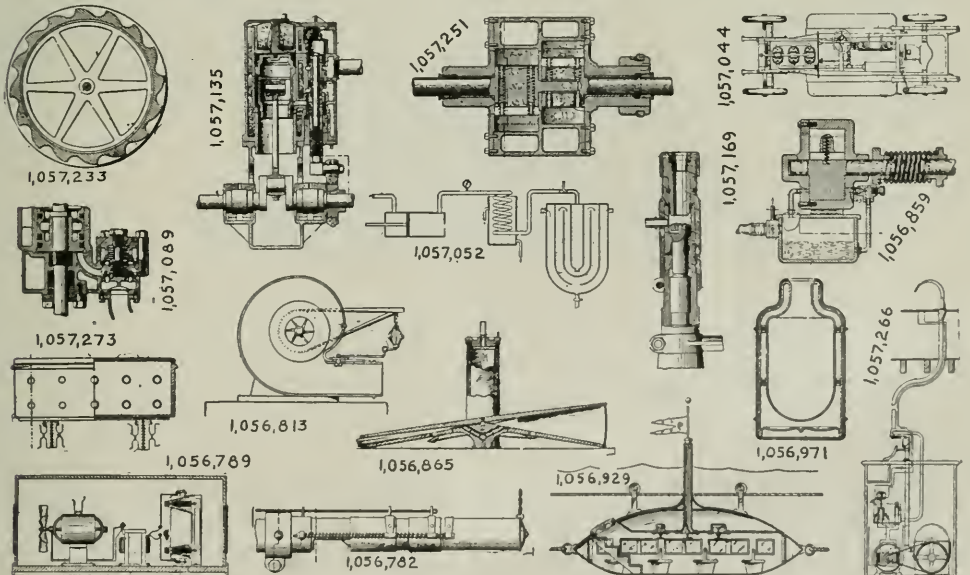
1,056,971. METHOD OF MAKING VACUUM-JACKETED VESSELS. CLYDE J. COLEMAN, New York, N. Y.



PNEUMATIC PATENTS MARCH 18.

- 1,057,044. PNEUMATIC ANTISLIP DEVICE FOR POWER-DRIVEN VEHICLES. BENJAMIN DOUGLASS, JR., Orange, N. J.
 1,057,052. PROCESS OF RECOVERING NITROUS VAPORS OR OXIDS OF NITROGEN DILUTED IN INDIFFERENT GASES. PHILIPPE AUGUSTE GUYE, Geneva Switzerland.
 1,057,089. VALVE MECHANISM FOR FLUID-COMPRESSORS. WILLIAM PRELLWITZ, Easton, Pa.
 1,057,135. AIR-COMPRESSOR. WILLIAM S. FAIRHURST, New York, N. Y.

- 1,057,169. HAMMER-DRILL. WILLIAM PRELLWITZ, Easton, Pa.
 1,057,233. FLUID-PRESSURE MOTOR. ANTOINE DE GEOFFROY, Paris, France.
 1,057,251. FLUID-CONTROLLED CLUTCH. HOWARD I. MANLEY, Kansas City, Mo.
 1,057,266. PNEUMATIC - DESPATCH - TUBE APPARATUS. ALBERT W. PEARSALE, Lowell, Mass.
 1,057,273. AIR-HUMIDOR. JAMES W. RAHN, Temple, Pa.



PNEUMATIC PATENTS MARCH 25.

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COMPRESSED AIR

MAGAZINE

EVERYTHING PNEUMATIC.

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No. 6



A PNEUMATIC CALKING TEST.

PNEUMATIC CALKING OF GAS AND WATER MAINS

BY CHAS. DOUGHERTY.

The economical and efficient calking of gas and water mains has always been more or less of a problem to the contractor. To satisfy the requirements of a properly calked main involves a rather tedious and slow operation when performed by hand, and this is responsible for the greater share of delay attendant upon the laying of such pipe. In addition, it is expensive and lacks uniformity and reliability, which is most frequent on the under side of the pipe on account of its inaccessibility.

It has been demonstrated, time and time

again, that such a joint calked by a pneumatic hammer, using lead wool, is not only a tighter, more satisfactory joint, but that the time and expense of calking it is cut in half, and at times even better performances than this have been obtained.

A practical test of pneumatic calking was recently conducted, in the presence of some 200 representatives of various gas and water companies from the vicinity of Boston. The test was held for the information of the Water Department of the City of Boston, in the yards of the Malden Gas Co., Malden, Mass., to determine the relative efficiency of a hand calked and a pneumatically calked joint for high pres-

sure water service, some 15 miles of such high pressure pipe being required to be laid for the Fire Department of the City of Boston. These mains in service will be under a continuous hydrostatic pressure of 300 lbs.

A hub and cap, with a special double groove high pressure joint, was provided by the Water Department for pneumatic calking against time. The demonstrator of the Ingersoll-Rand Company first yarned the joint with about 1½-inch of hemp rope, the remainder of the space being filled with lead wool and calked, strand by strand, in a total elapsed time of two hours. This included the preparation of the yarn and the lead wool for insertion in the joint. The hammer used was a Crown 53-H Calking Hammer, using a calking iron with a round shank.

The record made is a revelation, as compared with the calking of a similar joint by hand. Past records show that with two men it required an average of two days, of eight hours each, to complete such a joint, making about 32 man-hours by hand.

After the calking had been completed, the joint was submitted to a test, under the direct supervision of the Water Department. Calibrations were made at different pressures, so as to determine the expansion of the joint under varying conditions, up to a point when it showed a tendency to pull away. Up to a pressure of 600 lbs. there was no leak apparent, although the joint had spread considerably, about 15-1000 of an inch. The test for tightness shows up very much in favor of the pneumatically calked joint, as similar joints made with cast lead, and calked by hand would raise as much as 1¾-inches under a pressure of 600 lbs.

The above mentioned test was conducted under rather adverse conditions. In the first place the hammer used had been in service a number of years. In addition the calking irons provided were not of just the right size or shape for the special joint under test, and as a result a great deal of time was lost.

The results of this test show conclusively that the pneumatic calking process is faster and at the same time gives a joint superior to the hand calked one using lead wool, that it is also far superior to poured lead joints whether hand or pneumatically calked, and that it can be used in all situations likely to occur in practice.

AN AIR COMPRESSOR OIL CONSUMPTION RECORD

It is reported that a compressor which has been running at the power house of the Nevada Consolidated Copper Co., 24 hours per day for the last five years is compressing 16,000,000 cu. ft. of free air per gallon of lubricating, and without bad effects on the machine.

This is an excellent record and is worth looking into a little. A compressor with an intake cylinder 24 in. diameter, which is quite a common size, and a piston speed of 400 ft. per min., will compress, say, 1,200 cu. ft. of free air per minute, or 1,728,000 cu. ft. per 24 hours. Then the oil used per day, at the rate of consumption given in the above paragraph, would be only 0.108 gallon, or less than a pint for the 24 hours.

In COMPRESSED AIR MAGAZINE, September, 1911, a report of a month's running of the air compressors on the Panama Canal showed that at Rio Grande a gallon of lubricating oil was used for 3,360,124 cu. ft. of free air compressed; at Empire for 4,317,716 cu. ft.; and at Las Cascadas for 5,163,936 cu. ft., the Nevada oil consumption being less than one-third of the best of these.

THE ENERGY OF EXPLOSIVES

All commercial explosives owe their power of doing work to the expansive force of the great volume of gas into which they are converted at the occurrence of the explosion. The pressure exerted by this gas in the drill hole or other confined space in which the explosion is brought about is what makes explosive substances of value in mining or other industries, and is the primary cause of all those manifestations of energy that follow the firing of a charge. Common black blasting powder, on explosion, produces about 390 times its own volume of permanent gases; 40 per cent. dynamite produces about 530 times its own volume of permanent gases; and nitroglycerin produces somewhat more than 747 times its own volume of permanent gases. These proportions of volume of gases to volume of explosive are those that would be found if the gases were measured under normal conditions of temperature and pressure, but at the moment of explosion the gases are highly heated, and therefore tend to occupy a volume much greater than the figures given.

COMPRESSED AIR AND PNEUMATIC TOOLS IN THE FOUNDRY

BY W. H. ARMSTRONG.*

The first and most important thing to be determined in a compressed air installation is the compressor itself, and the first thing to be considered is the capacity of the machine. The average jobbing foundry requires a compressor of 300 to 500 cu. ft. per min., piston displacement. Large foundries may use up to 1,500 to 2,500 cu. ft. per min., and in such cases it is well to install two machines of different capacities, so that either machine may be used separately or both together, according to the changing air requirements. Novelty foundries usually require small machines of 50 to 100 cu. ft. piston displacement.

Whoever is installing a compressor for shop use should remember that more air is required this year than last year, and that still more will be called for next year, because more compressed air apparatus will be in use.

The compressor is ultimately responsible for the constant and steady operating of all the pneumatic tools and apparatus, so that care and judgment should be used in its selection. The drive of the machine will be determined by the type of power available. Steam, electricity or motor power, either applied direct, or by belt, chain or otherwise can all be made to give satisfactory service. The machine should be as nearly dirt proof, foot proof and automatic as possible. Compressors that would give perfect satisfaction when operated in connection with a general power plant and in charge of skilled engineers frequently "go to pieces" when installed alone in a foundry.

THE AIR HOIST.

Of the various pneumatic apparatus in the foundry it may perhaps be proper to speak first of the air hoist, as that is used in so many places and for such a variety of service throughout the works. It is used for unloading and distributing the incoming material and for loading the finished product when it goes out. It is valuable in conveying flasks in both directions between the foundry floor and the storage sheds; patterns to and from the pattern shop, or cleaned castings to the machine shop; for lifting copes or drawing

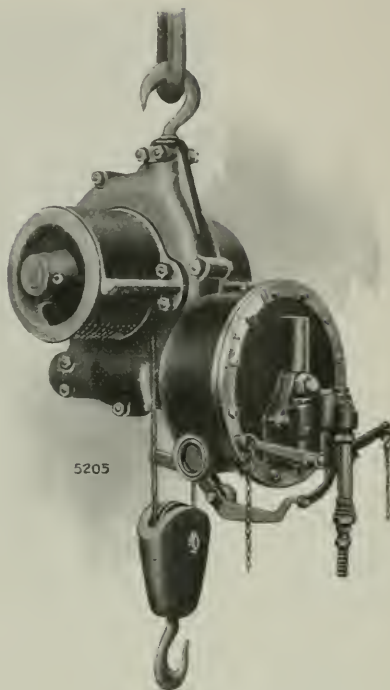


FIG. 1. IMPERIAL MOTOR HOIST.

patterns; conveying cores to ovens, for operating cupola elevators and core oven doors; for handling ladles before, during and after pouring, and lifting and conveying the castings from the pouring to the cleansing floor and then to the machine shop or elsewhere.

The most common types of air hoists are simple cylinders lifting direct or horizontal cylinders with or without multiplying shieves to reduce the length. The motor geared type of hoist is being largely adopted for much of the service where the single cylinders have been used, and especially for heavy traveling on jib cranes. Hoists of either type may often be applied to hand power cranes already in use without in the least interfering with the existing gearing, and at small expense. In the air hoist the power is applied to the load in the most direct and simplest manner. With this aid a boy can lift a given load a dozen times while a gang of men would be operating a chain block or a windlass. There is no noise, no jar and the load is always sustained. In foundries where an overhead traveler cannot be installed, air hoists suspended from trolleys running on a track are very satisfactory.

*Abstract of a paper before the Philadelphia Foundrymen's Association, Hotel Walton, Philadelphia, Pa.

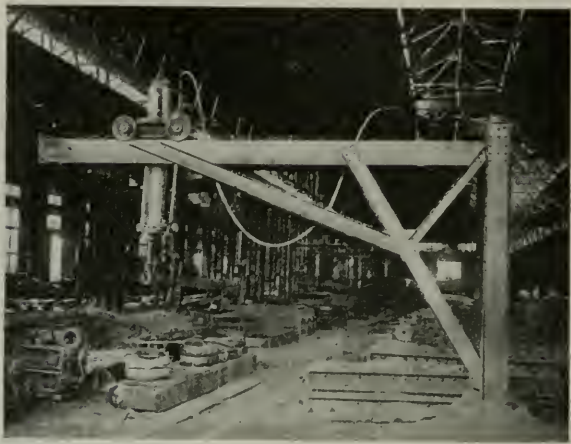


FIG. 2. AIR LIFT ON FOUNDRY CRANE.

COST OF AIR HOISTING.

Few realize how cheaply an air hoist is operated, besides its convenience and speed in handling loads. The following table compiled by Frank Richards requires no explanation.

Diam of cyl.	Effective area of piston.	Maximum weight lifted.	Cu. ft. of free air per 4-ft. lift.	Cost of air per 100 lifts.
2	3.05	274	0.74	\$0.0037
3	6.87	618	1.67	.0084
4	12.22	1099	2.97	.0149
5	19.09	1718	4.64	.0232
6	27.49	2444	6.68	.0334
7	37.42	3367	9.09	.0455
8	48.87	4398	11.88	.0594
9	61.85	5566	15.03	.0752
10	76.36	6872	18.56	.0928
11	92.39	8315	22.46	.1123
12	109.96	9896	26.73	.1337

COST OF PNEUMATIC HOISTING.

He estimates as the basis of the table that compressed air can be furnished for industrial purposes at 100 lbs. pressure at a cost of 5 cents per 1,000 cu. ft. of free air. It appears from this table that a hoist with a cylinder 6 in. diameter, with a piston rod 1 in. diameter and a lift of 4 ft., using air at 90 lb. pressure and allowing 30 per cent. additional to cover all contingencies, including the taking up of the slack of the hoisting chain, will lift more than a ton to a height of 4 ft. at a cost of \$.00035. A hundred of such lifts will thus be made, of course, for \$.035, or three and a half cents.

MOLDING MACHINES.

The molding machine now holds a prominent and most important position among labor saving devices in the foundry, increasing the output and improving the grade of the products. At first there was much opposition on the part of skilled molders to the adoption of these machines, and they were looked upon as luxuries where first successfully employed; but

now they have a permanent place among the necessities.

The molding machine is equally well operated either by the fully skilled workman or by the ordinary laborer. The necessity of economy imposed upon foundry managers in all lines of work make imperative the adoption of labor-saving molding machines. Practically every line of casting can now be economically and successfully molded on either power or hand machines. The range has been broadened to meet every modern condition of foundry practice, and the installation of the molding machine in a specific case is merely a question of type and of the local conditions to be met. The degree of efficiency and the speed of operation depend upon the selection of the proper machine, and then upon the personality of the operator. Molding machines are so designed as to be operated with air at a pressure of 60 to 80 lb.

THE SAND RAMMER.

The sand rammer seems to come next in the order of consideration among the pneumatic tools of the foundry. Due to the marked improvements that have been made in the construction of this device, which tend to lessen the shock on the operator, and the education of the operators in the proper way to handle them, it has made a permanent place for itself, even against strong opposition, on the grounds of economy, lower production cost, larger output and improved quality of product which follow its use, and the adoption has become more general.

The pneumatic rammer does much more than merely to supply the power for the work. It

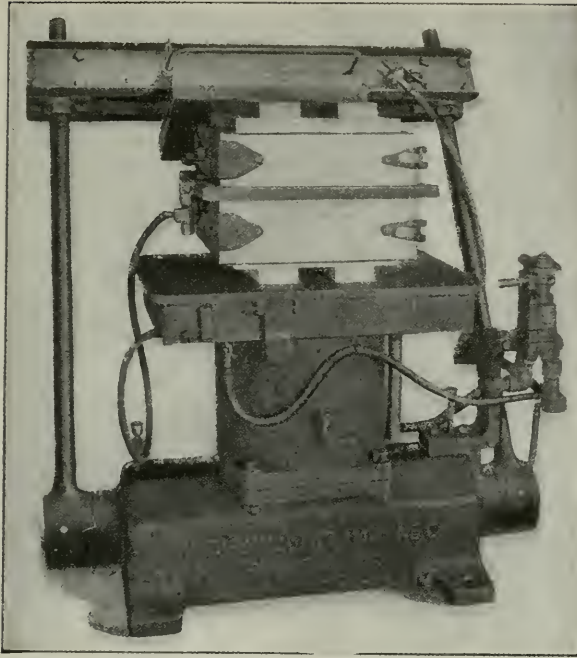


FIG. 3. PLAIN POWER SQUEEZER.

also changes the character of the ramming and gives the operator a variety of execution in the ramming which his muscles, at the best, could not command. The force, the direction, and especially the rapidity of the blows are so completely under the control of the operator that we might compare the manipulation of the rammer to the playing of a musical instrument. It relieves the moulder of the most fatiguing detail of his work.

In discussing recently the question of pneumatic sand rammers with the superintendent

of one of the best organized and most representative foundries in this country, he made the following comments:

The pneumatic sand rammer for foundry work has demonstrated that it is one of the greatest friends and labor savers of the progressive foundryman today. When the sand rammer was first introduced there was some criticism concerning it, mainly arising from the natural antipathy mechanics have for anything in the machine line; but as the operators became familiar with its use and recognized its



FIG. 4. JOLT RAMMER.



FIG. 5. BENCH RAMMER.

effectiveness, this feeling rapidly disappeared. Today in our foundry the men take kindly to these rammers, and use them entirely for work of every description.

Some writers claim that, while sand rammers are valuable for ramming drags, they cannot be used successfully on copes. We have exploded this contention completely in our shop and use the rammers on both copes and drags indiscriminately and with equal success.

The sand rammer is often put up against the jarring machine, and many claim that with the introduction of jolt machines the efficiency of the sand rammer is materially diminished. We have not found this to be the case. For medium size work that is made in quantities, we believe the jolt machine to be indispensable; even with this, however, the rammer is a very important factor in butting off the tops of the jolt ram and molds. When larger patterns are rammed, such as engine beds, sole plates, sub bases, etc., it has been our experience that the sand rammer is equal, if not superior, to the jolt machine.

This statement is made after taking into consideration the expense and labor incident to rigging up a pattern for use on a jolt machine, the tendency the mold has to sag upon being

rolled over, the bolting on the plates before rolling the drag, and such other details as are encountered in rolling over a large job. On the other hand, if the pattern is bedded in the ground or flask, and rammed up with pneumatic rammers, which may be done with unskilled help, much of the expense and delay is eliminated, while we are sure of a perfectly true job, conforming to every detail of the pattern.

The pneumatic bench rammer is a very handy tool as an auxiliary to the larger rammer. This rammer is very satisfactory for ramming a shelving pattern where the construction is such that it is difficult to ram under it with the larger tool. We find the bench rammer practically indispensable for work of this nature.

Speaking generally, it is my opinion that the sand rammer has increased our efficiency in

Size of Cope.	Time in Peining and Ramming.		Time Saved, Percent.
	By Hand.	By Sand Rammer	
12 ft. x 18 in. x 4 in.	5 min.	1 min.	80
12 ft. x 18 in. x 10 in.	10 "	1 1/4 "	85
6 ft. x 3 ft. x 6 in.	20 "	3 "	85
6 ft. x 6 ft. x 8 in.	35 "	8 "	77
8 ft. x 6 in. x 6 in.	1 hour	10 "	83
7 ft. x 3 ft. x 12 in.	1 " 30 min.	16 "	82
15 ft. x 30 in. x 16 in.	2 hours	27 "	77
12 ft. x 7 ft. x 16 in.	2 " 12 "	34 "	74
87 in. x 159 in. x 10 in.	4 "	40 "	83
19 ft. x 90 in. x 15 in.	8 "	1 hour 30 min.	81

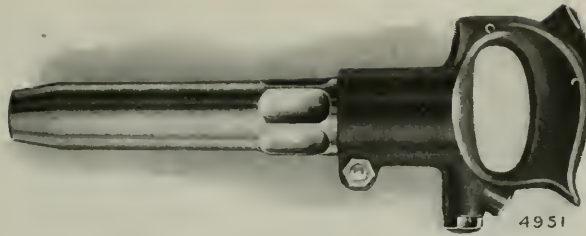


FIG. 6. IMPERIAL CHIPPING HAMMER.

this line fully four or five times, and since we have had them installed we would regret very much to be obliged to go back to the old way of ramming.

PNEUMATIC HAMMERS, DRILLS, ETC.

The value of the pneumatic chipping hammer in a foundry, as a saver of time and labor, is so universally conceded that the time has passed when it is deemed necessary to submit comparative figures, especially as much depends upon the conditions of operation and efficiency of the air plant. But suffice it to say that for all classes of chipping in foundry work, such as chipping fins off castings, cutting gates, risers, buttons off anchors, and general trimming, one man with one hammer of the proper size will do as much work as three or four men chipping by hand. These tools are made in different sizes, with piston strokes of 1 to 5 in., to meet different conditions. It is important that the proper size tool should be selected for the work, to insure the best results, the short stroke tools begin intended for the lighter work, requiring a light and

very rapid blow, the longer stroke tools for the heavier work, requiring a heavy and slower blow. The medium sizes, with 2 and 3 in. piston stroke, are the sizes most generally used for foundry work.

The rotating air drill is another very familiar labor-saving device, though its field of usefulness in a foundry is somewhat limited. It is more particularly a general shop tool, possessing a very wide range for drilling, reaming, tapping, flue rolling, running in stay bolts, studs, and other applications seemingly limitless. It has established itself next to the pneumatic hammer as a most generally used air tool.

Like the other pneumatic devices for foundry use the sand sifter also proves to be a time and labor and cost saver. It is made in different styles which it is not necessary to describe. The saving effected has been figured out as follows:

Including the cost of air, based on an efficient compressor installation, and figuring generally at 3c. per hour for maintenance of



FIG. 7. CHIPPING A CASTING.



FIG. 8. IMPERIAL MOTOR DRILL.

sifter, compressor, pipe line, hose couplings, etc., and also including labor at 15c. per hour, the cost would be 27c. per hour. When you consider that one man with one machine will screen in one hour as much sand as a man would riddle by hand in one day, and basing his time at \$1.50 per day, you will see that you effect by the use of the machine a saving of \$1.23 in one hour.

The air torch has been found a great time and labor saver, being used for skin-drying copes, molds, etc., for heating ladles, lighting cupolas and in casting repairing processes.

The air nozzle for blowing blacking on molds, cores, etc., is also a universal favorite.

This device is in the shape of a T, made of about $\frac{1}{2}$ in. pipe with the discharge end bushed to about $\frac{1}{4}$ in. The air is connected so as to cross the top of the T. A short section of hose which goes to the receptacle holding the blacking is connected to the stem of the T, and as the air is blown through the top of the T it siphons the blacking and blows it in a spray over the work, reaching and covering every corner and crevice.

CLEANING CASTINGS—THE SAND BLAST.

There is hardly an operation of the foundry of greater importance, and which contributes more to a satisfactory factory product, than the proper and thorough cleaning of castings.

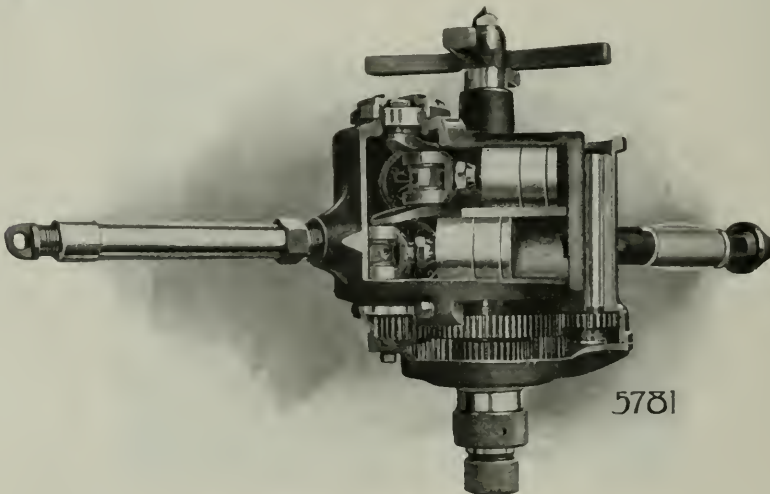


FIG. 9. SECTION OF IMPERIAL PISTON DRILL.

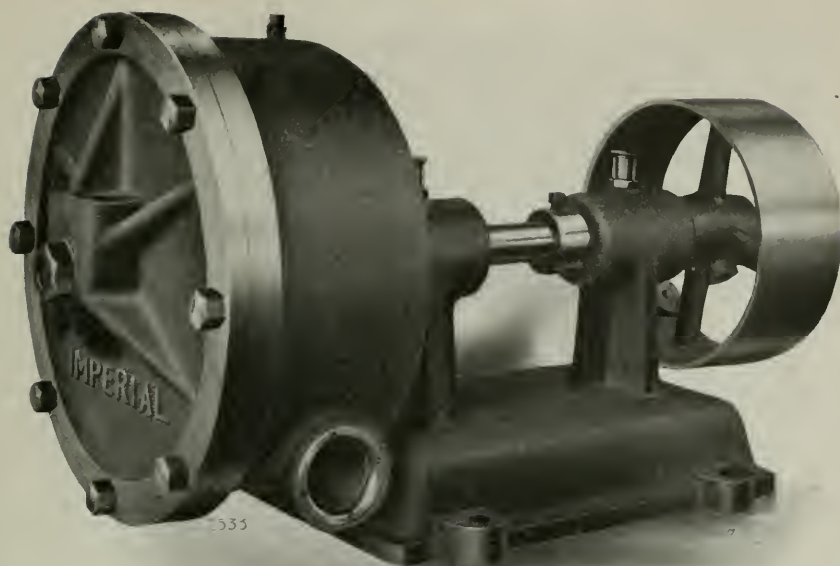


FIG. 11. STATIONARY AIR MOTOR.



FIG. 12. SAND BLAST APPARATUS.



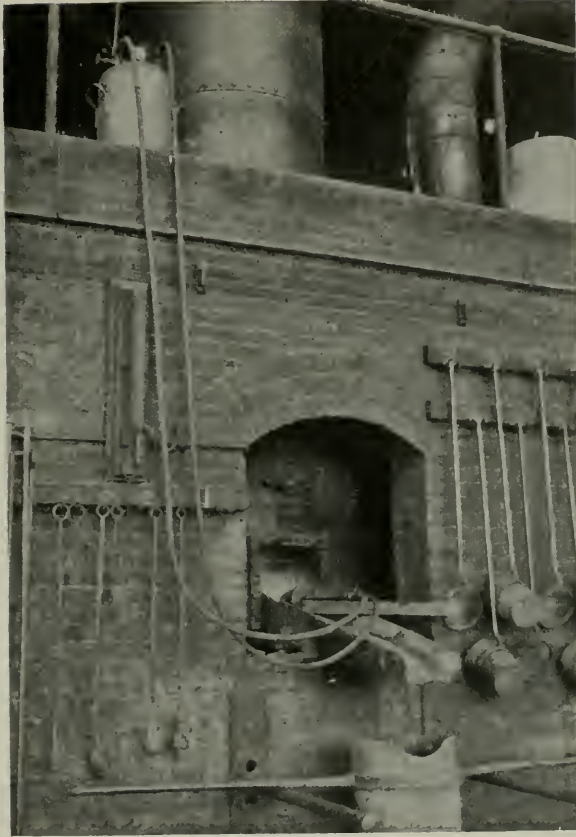
FIG. 13. BEFORE SAND BLASTING.

It has been an operation requiring time and patience, and involving heavy expense. The cleaning of castings is a subject that has been given unusual attention, being followed by experiments with various and sundry methods and devices for the successful and economical accomplishment of the desired results, including brushing, tumbling, pickling, blowing, etc.

These methods have each shown marked advantages as applied to particular classes of work, but as a commercial proposition for all classes of castings, large, medium and small, steel, iron, aluminum and brass, the solution has been found in the sand blast, and here again, compressed air plays a most important part and shows its superiority over other



FIG. 14. AFTER SAND BLASTING.



AIR TORCH LIGHTING CUPOLA.

actuating powers for general foundry work.

The sand blast, however, is by no means a late development, but it is only within recent years that it has been perfected to a stage where it produces satisfactory results, as applied to both external and internal surfaces, and also crevices, and combines economy in power, that is, in the consumption of compressed air, with effective savings in both time and labor, and a resultant total economy.

There are many makes, styles and kinds of sand blast apparatus on the market, and superior points are claimed by the manufacturers for each, some advocating the use of air under high pressure, and others under low pressure. The proper air pressure for sand blasting as applied to particular classes of work, has been the subject of much discussion among foundrymen and also sand blast manufacturers, and numerous theories have been expressed through the trade journals. There have also

been a number of tests conducted on different classes of work, with varying air pressures, and the consensus of opinion as expressed in the reports of these various tests, at least so many of them as it has been the writer's privilege to read, seems to favor the high pressure blast for all classes of work. It is conceded that the volume of air required is governed by the size of the opening in the sand blast nozzle, and the pressure maintained, based on the standard flow of air at a given pressure through a given size orifice. Therefore, the higher the pressure, the greater the volume of air used, but the amount and quality of work done increases correspondingly without added labor costs. It has been proven in these tests that twice as much work can be done at 50 lb. pressure as at 20 lb., at 64 lb. as at 30 lb., and at 72 lb. as at 40 lb. It has also been shown that for gray iron and malleable castings they can be cleaned best and quickest with an air

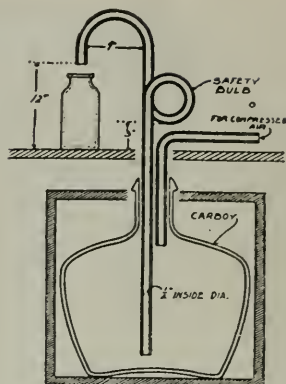
pressure of 80 lb.—brass and aluminum castings at not lower than 60 lb., while for steel castings, the hardest to clean, not less than 90 lb. The character of the material and its ability to withstand the impact of the sand will determine the pressure adaptable.

As a result of a very thorough test of the economy of sand blast cleaning, conducted by one of our leading technical schools, in collaboration with one of our largest steel foundries, I am able to give in tabulated form data showing that the total cost per ton for cleaning castings, with a modern high pressure sand blast, is less than \$0.80. This is figured on a basis of an equipment valued at \$4,000 and including interest at 6 per cent., and depreciation 10 per cent.; also power for exhaust system.

Air pressure generated	97.5
Air pressure at blast, lb.....	80
H. P. for air.....	53
Interest and depreciation.....	\$0.307
Maintenance, air	\$0.105
Maintenance, sand	\$0.279
Power for exhaust fan.....	0.0577
Nozzle	0.0104
Total	.4828
Labor	.316
Total	.7988

CLEANING BRASS CASTINGS.

An interesting modern sand blast installation designed by the Thomas W. Pangborn Company, Hagerstown, Md., includes sand blasting machine, sand separating machine, sand elevator, exhauster and dust arrester. The sand blast is used extensively in connection with tumbling barrels. In one case a load of 360 lb. of small brass castings were put into the barrel just as they came from the mold and the entire time consumed for the cleaning was 15 minutes, which included the loading and unloading of the barrel. The average pressure maintained on this run was 70 lb., and the abrasive used was No. 40 Angular Grit, through a $\frac{1}{4}$ in. nozzle. In a paper by Professor William T. Magrader before the American Society of Mechanical Engineers, he said that the precise locating of the blast nozzles as to distance and angle of delivery had much to do with the celerity and efficiency of the sand blast operation.



SIPHONING FROM CARBOYS

The sketch here reproduced from the *Chemist-Analyst* shows a convenient device for siphoning acid, ammonia, etc., from carboys. The tubes shown are made of $\frac{1}{2}$ in. glass and the air pressure should be controlled by a slow opening valve—preferably three-way—after expelling the contents of the carboy, or any portion of them, when only the pressure of the atmosphere is left the contents of the tube will flow back into the carboy and there will be no dripping.

NATURAL GAS THE IDEAL FUEL

Natural gas is the best fuel known to man. No advance beyond it is possible, but to secure the best results some scientific knowledge is required in regulating its combustion. Since it is the perfect fuel, it admits of application to almost every purpose to which fuel can be turned. The principal exception is in the manufacture of iron from its ores, and in other similar metallurgical processes. In the working of iron ore rolling mills, forges and foundries, and in the production of steam for all its multifarious applications, in the direct use of heat in the manufacture of glass and cement, in the burning of pottery, tile and brick, it is, as before said, the perfect fuel. It effects important economies and greatly improves the quality of production at the same time. But superlatives in describing its advantages and value ought to be reserved for its use as a household fuel. It is here that it does the greatest good to the greatest number. It lightens and simplifies the labors of housekeeping to a surprising extent.—*Dr. Edward Orton.*

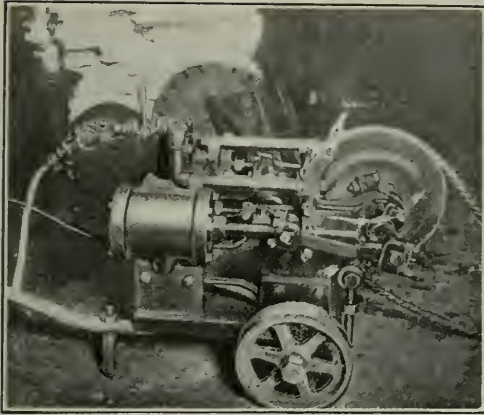


FIG. 2.

COMPRESSED AIR TOOLS IN RAIL-ROAD SHOPS

In every up-to-date machine shop employing say a dozen men or more, and especially in every railroad shop, a constant compressed air service is now to be regarded as a necessity, and wherever the air is thus ready at hand new devices are constantly being devised for its employment. In the big railroad shops these devices are too numerous and too familiar to be noticed at all unless they possess some features of novelty.

The two half tones on this page, reproduced from the *American Machinist*, show two home-made devices in construction in the big shops of the Northern Pacific at South Tacoma,

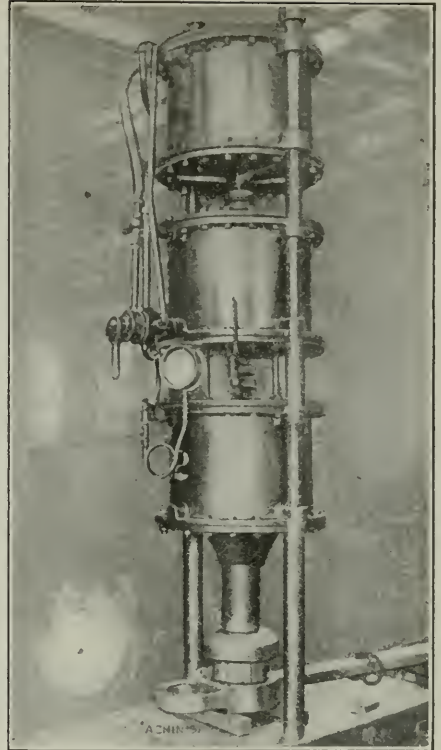


FIG. 1.

Washington. Neither of these devices require much explanation.

The tandem press, Fig. 1, merely applies three times the force of a single cylinder while

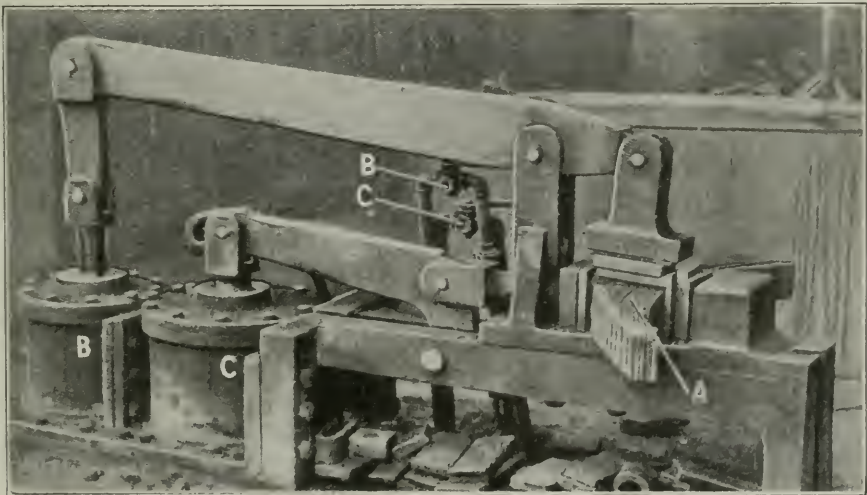


FIG. 3.

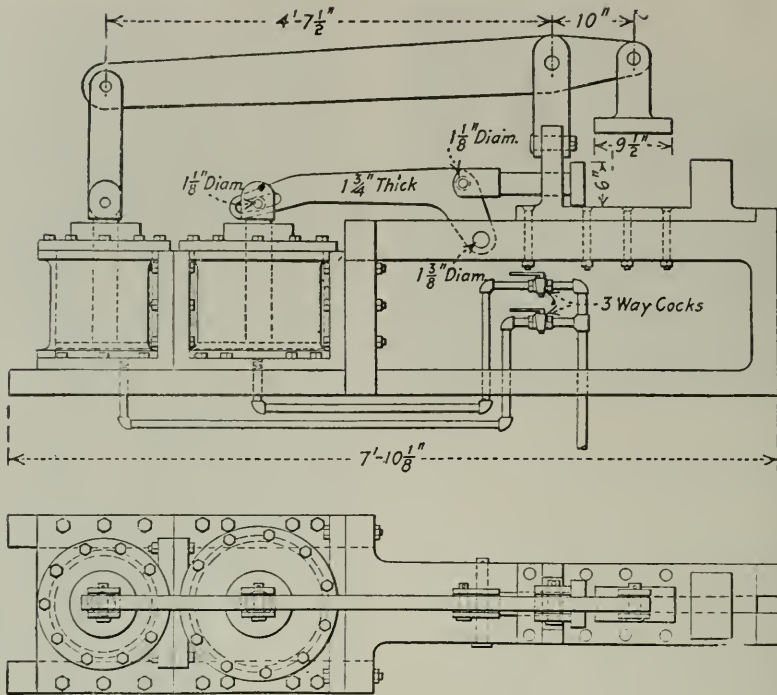


FIG. 4.

occupying no more lateral space. For lifting the pistons the air is applied only to the lower one, the lower ends of the other cylinders being in free communication with the atmosphere. In applying pressure to the work as required, the lower cylinder alone may be used, and if that is not sufficient then either or both of the others may also be thrown into service. There is thus no greater volume of air used than is actually required for the work.

Fig. 2 is simply a two cylinder engine mounted upon a hand-drawn truck to be run around the shop for driving temporary boring bars, valve facing machines, drills, etc. The power is transmitted by a round belt or rope from the grooved wheel on the crank shaft, this drive requiring no careful alignment.

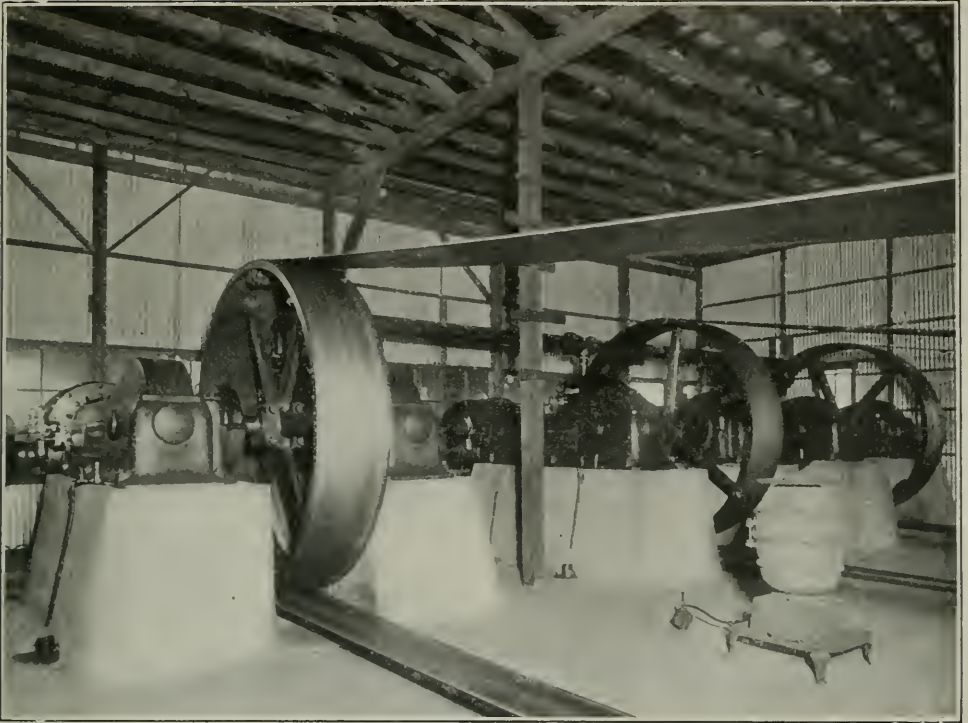
Figs. 3 and 4 show a machine, made in the shops of the Central of Georgia Ry., Macon, Ga., used for compressing the hot bands around springs for car trucks. The spring leaves are assembled by pressing them together and slipping a retaining ring in place. Then the hot band is driven on, the spring is placed as shown at A, and the air is turned into cylinders B and C, forcing up the pistons and com-

pressing the spring band all around, making it hug the spring leaves so that as it cools and shrinks they are held snugly together.

SCULPTOGRAPHY

This is a process which has been perfected by a Boston inventor for making plaster or metal casts of the human body or any portions of it that may be desired. Compressed air, by an operation similar to that of the cement gun, sprays over the part to be reproduced a coating of warm liquid which quickly solidifies forming a hard shell or mold which is then removed and plaster casts may be made in the usual way. It is claimed that the liquid used will not stick to the hair, eyebrows or mustache, and the texture of the skin is perfectly reproduced.

Dr. Bertelsmann has written a treatise on the influence of gas and its use on the smoke problem, and has proved that the use of gas engines in the industries would lead to a solution of the smoke abatement questions never to be reached by direct burning of coal.



ORONOGO CIRCLE COMPRESSOR PLANT.

ELECTRIC DRIVE IN ZINC MINING

BY S. A. ALLISON.

Since the introduction of electrical power in the Joplin lead and zinc mining district in Southwest Missouri three years ago, practically every producing plant of any capacity has re-installed with motors, and is now using the cheaper and more efficient power supplied by a service which has never yet failed.

One of the latest plants in the district to re-equip with new machinery, driven throughout by electricity, is the famous Oronogo Circle Mill at Oronogo. The Oronogo Circle is one of the oldest producers in the district and has been listed regularly in the "turn-in" columns for nearly twenty years.

On December 1, 1912, the Oronogo Circle completed its re-equipment of a modern, up-to-date in every respect, 1,000 ton capacity mill. The plant is under the able management of A. J. Burnham, a practical mining man of years experience in the district, and who has a record of driving a mine to its greatest efficiency and production at all times.

When it was decided to re-equip the famous old producer, careful consideration was given

to the selection of the best machinery and equipment possible, for the plant is blocked out as a producer for the next twenty years.

With an Ingersoll-Rand Class F. 1 Calyx Diamondless Core drill the property has been prospected, with ore finds which will run for at least the period mentioned. The ground has been tested to a depth of 350 feet. Ore bodies running in high grade have been found on the 135, 180 and 260-foot levels, and all of these levels are being worked.

The ground is being broken with 18 3/4 inch Ingersoll-Rand rock drills and with eight C 110 (one man) drills. The ground work is done in *one* eight-hour shift and sufficient dirt is broken to keep the mill running *three* steady eight-hour shifts. The average hoisting of the mine is 26,000 tons of crush rock in a month.

The rock drills in the ground are run by three 800-foot two stage Ingersoll-Rand Imperial Compressors, the very latest model. Each of these compressors is driven by a 100-horse-power motor.

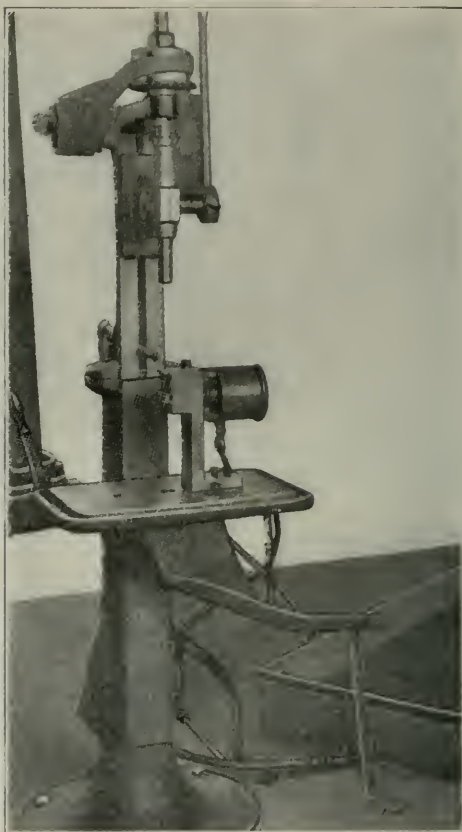
There are two 4 inch two stage centrifugal pumps and one 4 stage 10 inch centrifugal

pump, with two cross-head Cornish lift pumps installed to meet any emergency in wet ground.

There are few, if any, plants in the entire district better equipped than is the Oronogo Circle. The new plant has been working long enough so that the efficiency of its machinery working as a unit has been carefully tested. Mining men in all parts of the district have pronounced it one of the best, if not the best, in the entire camp.

Practically all of the new plants in the district, however, are now being installed similar to the Oronogo Circle. Electrical power is found to be the best and the cheapest, and the power that practically never goes down. The types of machine used to break the ground have been found to be the best by far that can be used in the sheet-ground district in the heart of which the Oronogo Circle lies.

The olden days when it required *three* shifts in the ground to break enough dirt to run the mill *one* shift is passed when the largest type mill yet built here can be kept running three full shifts with ground broken and hoisted in one shift.



STAYBOLT CHUCK ON DRILL.

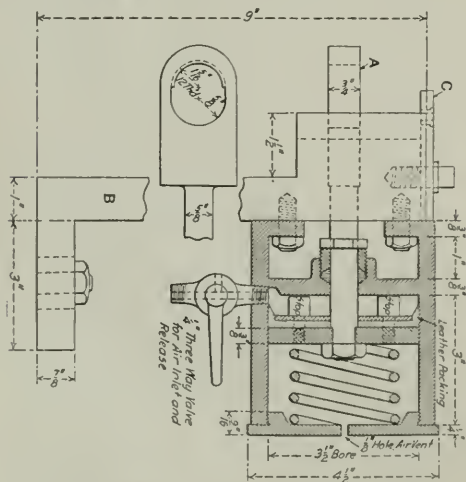
water flows out through the drilled hole and gives immediate warning.

The illustrations, from the *American Engineer*, show a device for holding the staybolts for drilling as described by J. C. Breckenfeld, of the St. Louis and San Francisco shops, Springfield, Mo. With the arrangements previously used six or eight drills were broken per day in drilling from 175 to 300 staybolts. With the device here shown in use the output was increased to about 800 per nine-hour day, and the breakage of drills was reduced to one or two and sometimes none per day.

The holes to be drilled are 7-32 in. diameter and 1½ in. deep. The bolt is slipped up through the large opening in the slide A until it touches the under side of the projecting plate C. The air is then admitted to A the cylinder, this operation pulling slide and clamping the staybolt in the V notches and locating the end of the bolt exactly central under the bushing or drill guide in plate C.

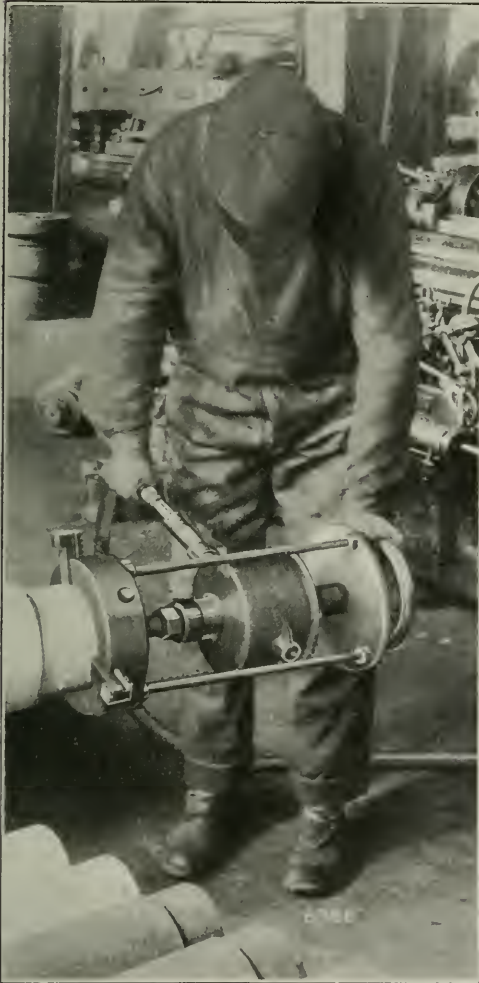
PNEUMATIC CHUCK FOR STAYBOLT DRILLING

A constant job in railroad shops is the drilling of tell-tale holes in staybolts, this being a government requirement. The hole is drilled axially into the outer end of the staybolt to such a depth as to project into the steam or water space when the staybolt is in service. If the staybolt cracks or breaks the steam or



PNEUMATIC STAYBOLT CHUCK.

The drill, which runs constantly, is fed down by a hand operated lever until a stop is reached, which gages the depth of the hole. The lever is then released and a counterbalance raises the drill out of the hole while the operator with his right hand operates the three way air valve, which allows the bolt to drop into a chute below, while with the left hand another bolt is inserted, and so on, until the operator stops for a rest.



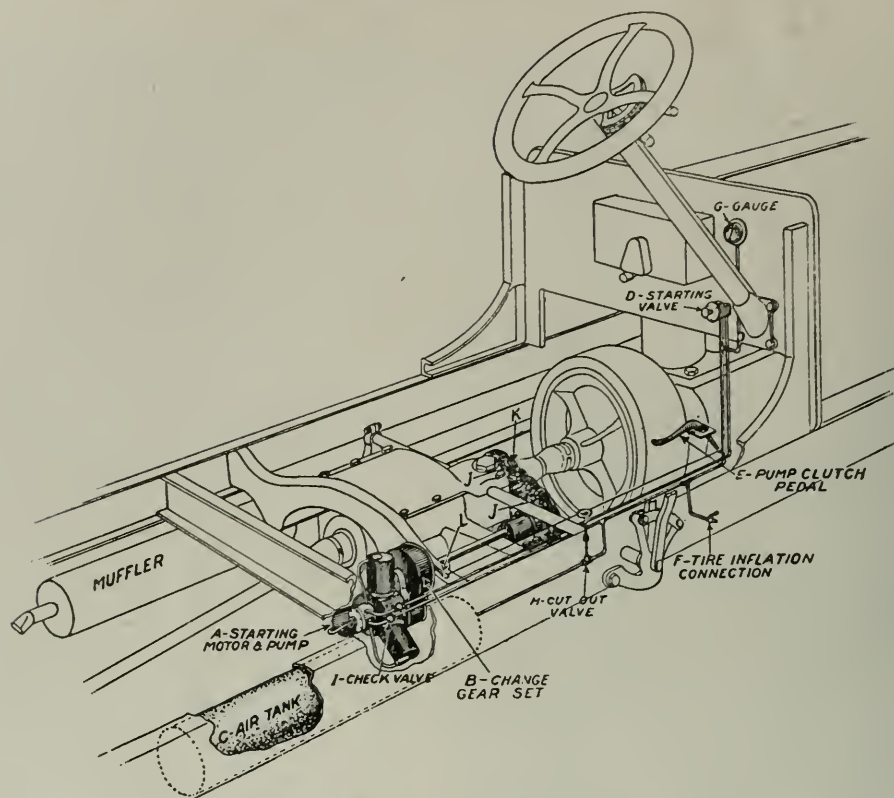
A HANDY PNEUMATIC CENTERING DEVICE

The half tone shows a portable pneumatic centering device in use in the Painted Post shops of the Ingersoll-Rand Company. As here shown it is being used for recentring a lot of

compressor shafts which have been roughed out and cut off to approximate lengths and are now ready for the final turning and grinding. The universal lathe chuck is connected, by three rods which serve as guides for the drill, with a casting at the back through which the feed screw passes. The drill chuck fits a central bushing in the large chuck, this ensuring the accurate centering of the piece. The chuck is quickly secured on the end of the work by the usual socket chuck-wrench. Then the operator controls the air supply with his right hand and turns the feed wheel with the left hand. When the drilling begins he can note the turns he gives the feed screw and so get the centers very nearly the same size. The Imperial Piston Drill is used, giving a positive motion with ample power.

COMPRESSED AIR DISLODGES ANCHOR ICE

An apparatus for utilizing compressed air to dislodge the anchor ice which forms in the ports of the water-works intake cribs during the winter was installed at the Two Mile crib of the Chicago, Ill., water-works during the fall of 1911. It is arranged as follows: A new 10x8x10-in. Westinghouse air compressor was installed and arranged to discharge into a receiving tank of about 50 cu. ft. capacity. The operation of the compressor is arranged to give a maximum of about 80 lb. pressure in the receiving tank. When any of the ports show signs of being blocked by anchor ice a standpipe running down into the center of the port is connected with the air-receiving tank by means of a 2½-in. hose. After the hose and standpipe are in place the full load of air under 80 lb. pressure is discharged through the hose and into the port by operating a quick-opening valve at the air tank. By giving the full head of air through the port and from expansion of the air in the water the force to dislodge the ice which has formed on the walls of the port is secured. In former years the anchor ice was dislodged by using water under pressure in practically the same manner as described above. It was found, however, that the water would not give the same result as a like quantity of air under the same pressure, and after making tests of the use of water as compared with air the change was made to the air apparatus.



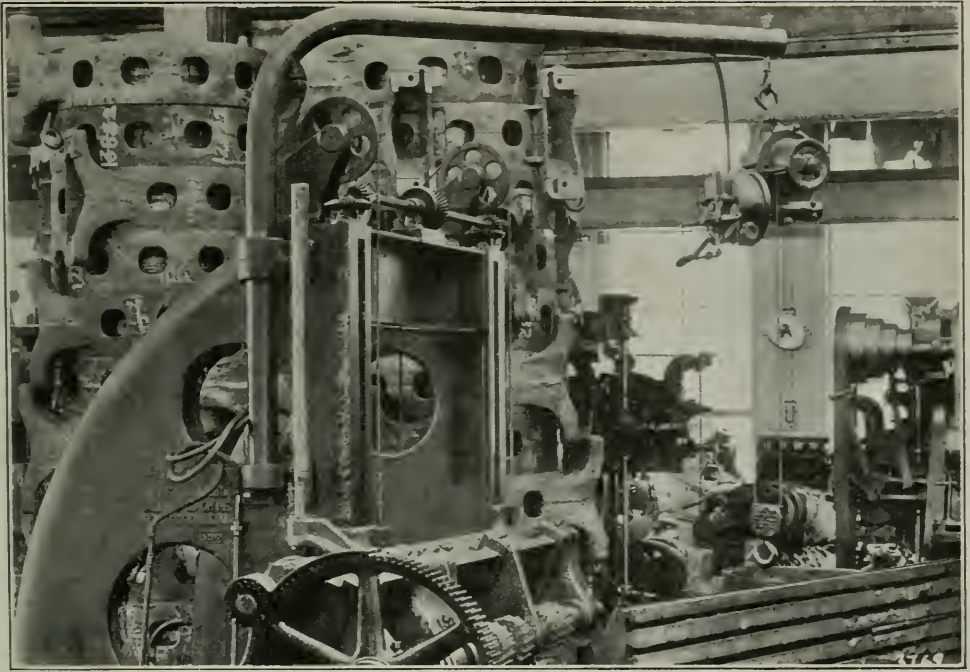
COMBINED AIR PUMP AND AUTO STARTER

A motor starting system which can be installed on any gasoline car, truck or motor boat has been designed by the Motor Starting Co., of Akron, O. At *A* is shown a combined three-cylinder pump and starting motor which supplies pure air under pressure to the tank and operates as a compressed air motor to start the gasoline engine by rotating it until it takes up the regular cycle under its own power. The change gear set is attached to the starting motor at *B*. The gear set is always in position to start the engine without any gear shifting, and it is only necessary to press the starting valve *D* on the dash. The pump clutch pedal *E* puts the pump into action for compressing air while the engine is running, regardless of speed. At *C* is shown an air storage tank 7 inches in diameter and 36 inches in length. Sufficient air may be kept in this tank to start the motor and to inflate tires at all times. The automatic starting valve *D* admits air to the engine merely by pressing the button, and closes when the button is released. A connection for the air

hose for inflating tires is shown at *F* at the side of the car, and a dash gauge *G* is supplied to indicate the amount of air in the tank. There is a safety cut-off valve *H* which prevents leakage from the tank to the motor when the car is to be stored for some time. There is also a check valve *I* in the air line. The motor turns the engine by means of a sprocket and silent chain drive to the transmission shaft at *K*. An adjustable support is used for mounting the air pump and gears, this support being made to fit any car. The total weight of the apparatus installed is between 50 and 60 pounds.—*Horseless Age*.

PNEUMATIC HOISTS IN MACHINE SHOPS

The most numerous and extensively used compressed air-operated device in machine shops, and probably the most valuable, is the pneumatic hoist. The straight-cylinder, direct-lift hoist, being the simplest and the first thought of, was in the beginning practically the only device employed, and it is found in use wherever there is a permanent supply of compressed air; but it has seriously objection-

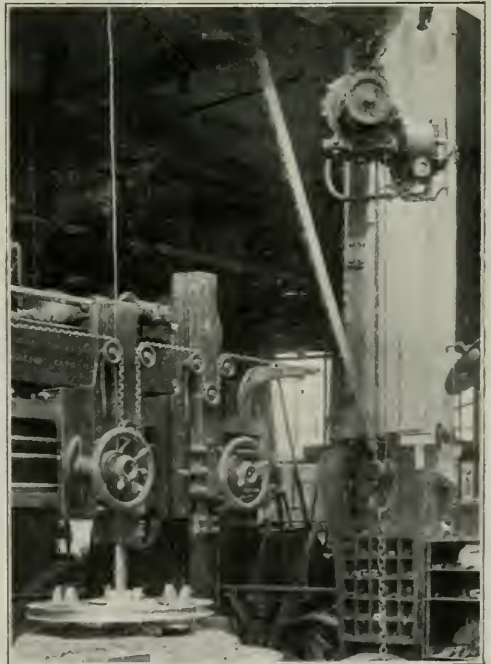


IMPERIAL MOTOR HOIST FOR A MILLING MACHINE.

able features. It is not as cheap as might at first be thought, especially when the conditions of installation which it imposes are reckoned with.

The overhead room required for the vertical cylinder hoist and the length necessary for the hoist with the horizontal cylinder are always bad and often prohibitory. The movement of these hoists is not positive, and unless the air valve is very sensitive and manipulated with care both hoisting and lowering are uncertain and jerky and the inevitable leakage makes any long suspension of the load practically impossible.

The pneumatic motor hoist, which developed later, must be recognized as a decided improvement. It requires a minimum of head room independent of the height of lift, which may be as great as any class of work can call for. In commencing a lift the slack is taken up by the use of very little air, and in the actual hoist the air consumption is exactly according to the load. Both hoisting and lowering are absolutely and delicately controlled. The hoist, for instance, can be started and stopped a dozen times within an inch of vertical travel. The load is positively held for

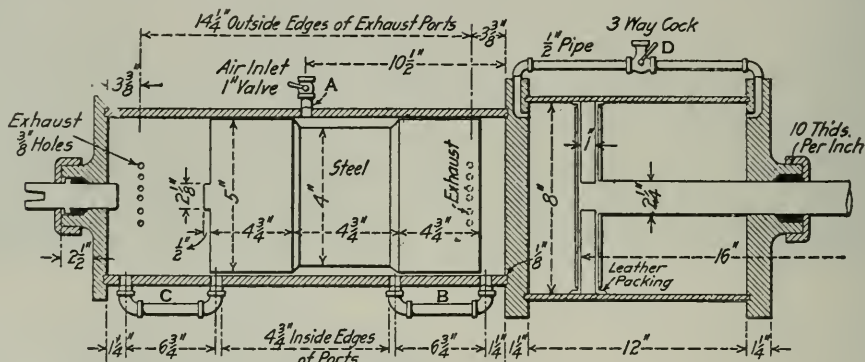


IMPERIAL MOTOR HOIST FOR BORING MILL.

unlimited time and cannot be accidentally dropped under any circumstances. The hoist may be suspended in a fixed position, can be mounted on a jib crane or on an overhead trolley.

Fig. 1 shows the Imperial Hoist serving a horizontal milling machine in the plant of the Bullock Electric Company, East Norwood, Ohio, and Fig. 2 shows a hoist of the same type which loads and unloads a vertical boring mill in one of the plants of the Otis Elevator Company.

The Imperial Motor Hoist is made in five sizes, with capacities, respectively of $\frac{1}{2}$, $1\frac{1}{2}$, $3\frac{1}{2}$ and 5 tons, with a lift of 20 feet for either.



POWERFUL PNEUMATIC HAMMER.

A NEW HEIGHT RECORD

A new height record of 6,000 meters (3 $\frac{3}{4}$ miles) was made recently by M. Perreyon, chief pilot of the Blériot school, with a Blériot monoplane fitted with a 160 horse-power Gnome motor. Perreyon rounded the field in great circles, steadily rising until he had reached a height of 5,700 meters (18,700 feet), after which he flew in a nearly straight line in his endeavor to reach a still greater height. After an ascent lasting about an hour, he finally reached 6,000 meters (19,685 feet). The air was so clear that he could see as far as Rouen, a distance of 75 miles, and he was also visible from the ground throughout the whole of his flight. The 100 liters of oxygen which he carried gave out, and so he was obliged to descend at once. He reached the ground in 12 minutes from this tremendous height. He was not troubled with dizziness, as he inhaled oxygen—a thing which none of the other aviators have done who have flown to such a great height.

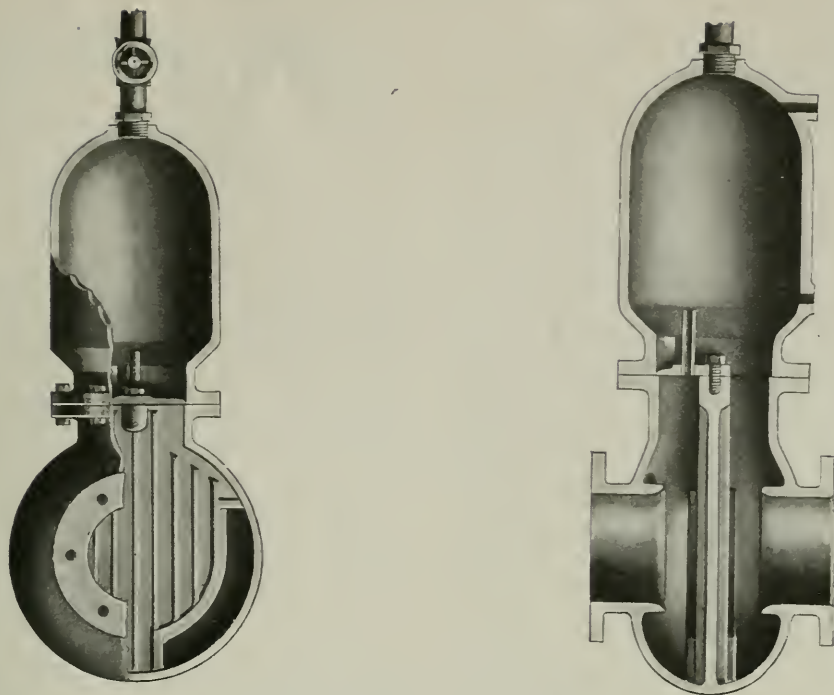
A HANDY PNEUMATIC HAMMER FOR BOILER SHOPS

The drawing and description of this hammer was sent to the *American Machinist* by I. C. Brekenfield, St. Louis and San Francisco R. R. shops, Springfield, Mo. It has been in use several years and has proved efficient as a staybolt breaker and a riveter, as well as for general use. The working cylinder, 5 in. diameter, contains a floating piston. Each end of the cylinder communicates with the atmosphere by means of the six $\frac{3}{8}$ -in. exhaust holes drilled $\frac{3}{8}$ in. from each end. These holes are covered when the piston approaches the ends of the cylinder and the enclosed air forms a

cushion. The compressed air enters the cylinder at A, fills the annular space at the center of the piston and passes back of the piston through pipe B, driving it forward. A projection is provided on the piston for striking the hammer, and the latter can be changed at will. When the piston is in the forward position the air passes through pipe C, the connection B being covered. At the rear of the tool is an 8 in. cylinder with piston and rod which are used to brace the hammer and hold it against the work. For certain conditions of work this piston may be made to pull instead of thrusting.

NEW IRON MINE SHAFT SINKING RECORD

Working twenty-six days during the month, with no Sunday work, crews of shaft sinkers employed on eight-hour shifts performed the remarkable feat of sinking New C shaft at the East Norrie mine of the Oliver Iron Mining Co. 105 feet in March. Not alone was the



SECTIONAL VIEWS OF AIR SEPARATOR.

A SEPARATOR FOR COMPRESSED AIR SERVICE

shaft sunk more than one hundred feet in the twenty-six days, but the heavy steel sets were placed in position, the concrete slab-lathing was put in place for the entire distance, also the back-runners. The magnitude of the work may be better understood when it is realized that 24,600 cubic feet of rock was broken and hoisted to surface, and the labor of placing the shaft equipment, consisting of two skip-roads, one cage-road, ladderway, pipe compartment, counter balance and back-runners, completing a modern five-compartment shaft, was all performed in twenty-six days.

Each piece of concrete slab-lathing weighs 130 pounds, and the steel sets are made of very heavy material. Six Jackhammer drills were used in sinking, and the efficiency of the machines and skill of the crews engaged in the work may be judged from the wonderful results obtained. Capt. Gus Erickson and his men are to be congratulated. They have done a fine piece of work in record time, bringing nearer the day when old C shaft will be dismantled and the scene of mining activity shifted from the encroaching residential district of that section of the city to the much better location one thousand feet farther south. —*Ironwood (Mich.) News Record.*

The readers of COMPRESSED AIR MAGAZINE may be assumed to be generally familiar with the fact that all air with which we have to do normally contains considerable quantities of aqueous vapor, and that when the air is compressed there is more of this vapor than the air can carry and more or less of it is condensed into actual water, but still minutely commingled with the air.

When air is at its highest pressure and its lowest temperature its capacity for aqueous vapor is at the minimum and its quantity of entrained water will be the greatest possible from the original content, and if while the air is in this condition the condensed and liberated water can be separated and abstracted from the air it cannot be heard from as a trouble-maker later. It has been learned very slowly in practical compressed air working that this water distributed in minute particles through the air will only settle down through the air and separate itself very slowly. It will not settle in the bottom of the receiver, as it has been assumed to do, but will be carried along through the piping to the drills or pneumatic tools or other apparatus where the air is used.

It happens, however, that the water may be easily separated from the air if the necessary provision be made for it. A separator which has proved itself effective with steam is equally effective with air in removing both water and oil.

The two cuts on preceding page are vertical sections at right angles to each other (and unfortunately not both exactly to the same scale) of the well known Cochran separator, so effective in separating oil and water from steam that it now claims to have 10,000,000 H. P. of steam boilers under its protection.

The separator as here shown is designed for bolting into a horizontal pipe. The liquid particles, water or oil strike against a central vertical ribbed baffle-plate adhering to the surface and dripping down into the receiver below, from which the accumulations can be drawn off as they accumulate. The receiver and also the baffle plate can be removed for cleaning without disturbing the pipe connection. Built by the Harrison Safety Boiler Works, 17th St. and Allegheny Ave., Philadelphia, Pa.

A MUCK THROWING KINK

The readers of COMPRESSED AIR MAGAZINE should by this time be quite well informed of the fact that the progress of a tunnel heading depends largely upon the rapidity with which the "muck" is cleared away after a blast, and they will therefore be able to appreciate the following operation as described by Mr. J. H. Graham in a recent issue of the *Engineering Record*.

After the "cut shots" and "side shots" had been fired, and before shooting the "roof shot," a "muck shot" was prepared. This consisted of eight sticks of 60 per cent. giant gelatine, placed against the face immediately under the "roof shot," and covered with sand. In one of these eight sticks was placed a "delayed electric exploder," which was connected with the roof holes, and exploded a second after the "roof shot" went off. The rock from the roof holes would drop vertically upon the "muck shot," which would then go off and hurl the muck away from the face. In this way the immediate face of the heading was cleared of muck, and one hour was saved in making room to set up the columns for the next round of holes.

OZONIZING THE AIR IN PUBLIC BUILDINGS

The Westinghouse Electric and Manufacturing Company is placing on the market an apparatus for purifying the air of public buildings, clubs, residences, etc., by means of ozone. The ozonizer consists of a step-up transformer, tubes for generating the ozone and a regulating switch, all contained in a portable case. The function of the transformer is to raise the voltage of the supply circuit to that required by the ozone-generating tubes. These tubes are of glass of special construction, having an outer coating of metal made to adhere closely to the glass by a special process. The inner walls of the tubes are lined with a metal mesh which forms the ozone-generating surface.

The generating cylinders are located above the transformer and stand vertically, so that the warm air rising from the transformer and from the inside of the generating tubes causes an upward draft, drawing in fresh air at the bottom and giving off a uniform flow of ozonized air at the top. On top of the case is a knurled knob connected to the regulating switch located inside the case, which is connected to the generating tubes in such a manner that, by turning the knob to the positions indicated on the dial, the number of tubes in operation may be regulated from one to four, with a corresponding change in the unit of ozone.

COTTON SAMPLES STORED IN VACUUM TUBES

The third annual opening of cotton samples, first stored in vacuum by the department of agriculture in 1910, took place recently. Careful, practical and technical examination fails to disclose the slightest appreciable change in the cotton. This result confirms the previous tests, and renders it very certain that storage of standard types of cotton in vacuum tubes is a practical solution of the question of the permanency of such standards. The United States official grades are stored at the department of agriculture at Washington in vacuum tubes to be opened from year to year and used as models for the sets of grades sold by the department in accordance with law.

Peary went through two years in the Arctic without a "snuffle" and nearly died of grippe caught in a closed cab.

COMPRESSED AIR

MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

W. L. SAUNDERS, -	-	-	-	Editor
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THE PNEUMATIC PACEMAKERS

It may be noted by the readers of our present issue that its contents have largely to do with the variety of air operated devices which are in use in the shops, and which in so many instances supersede or supplement the physical strength or the dexterity of the workman in the mechanical trades.

It will generally be considered that the most extensive and important of all compressed air employments is in the driving of the rock drill and its now numerous progeny, as employed in the wide range of work covered by the several lines of quarrying, mining, tunneling, foundation sinking, and in rock breaking and excavation work for whatever purpose.

This estimate we will not question; but still the use of pneumatic tools, distinctively so called, in all the metal trades, of molding machines in the foundry, of the tools which now do all the work, of the boiler shop, of presses and hoists in all the shops, and especially of the endless variety of special pneumatic devices, mostly homemade, which are now to be found in all the railroad shops and in many others, these collectively form an imposing array and cover a vast field of activity and usefulness.

It is natural as we note these developments to at once consider and try to measure the economics effected, the saving of time and labor as compared with the cost of installation, operation and maintenance of the new devices. But we do not go very far in that before we find that it is too late a day to be figuring about the cost of pneumatic tools in the shops, to be able to state in dollars and cents the actual saving accomplished in a given time. We might as well try to figure the cost of the telephone in the modern office to compare it with the cost of correspondence and messenger service which it supersedes.

And even if it were theoretically possible to make actual computations on both sides so as to deduce a balance, it would be impossible in practice, because so many more kinds of things are done than would have been done under the old arrangements and because the speed of working has been quickened all around.

On another page we present a sketch and a slight description of a staybolt driller gotten up in a railroad shop with an account of the

great increase effected in the output. The pneumatic device was most important of all not in itself, but in that it furnished the opportunity and the stimulus for a systemizing and a rearranging of the entire cycle of operations. It would seem that in this case motion study could be carried no farther. To drill holes $1\frac{1}{2}$ in. deep in the ends of 800 staybolts in 9 hours, would allow only .675 min. for each, without a single minute of respite, which latter detail would be impossible, and the actual time per actual unit could scarcely have averaged above .5 min.

Supposing a staybolt in place and the drilling going on, the operator continues to press down the drill feed lever with his right hand, and when the stop is reached and the hole is drilled to the required depth he lets go of the lever and the machine automatically pulls the drill up out of the hole. Then the right hand operates the air valve, the staybolt is released and drops, and the left hand, which has in the meantime picked up another staybolt, inserts it in its place, which is all that the left hand has to do. The right hand has only to turn the air valve again and then begin to press down on the feed lever, which completes the cycle of operations. Of the 30 seconds allowed as above, probably 25 of them can be occupied in the actual drilling, and all the operations involved in the changing of the staybolts can be comfortably accomplished in the other 5 seconds. When it has once been made apparent that this pace can be comfortably maintained, any return to the old gait can not be thought of.

CARE AND LUBRICATION OF AIR COMPRESSOR

The following is from Safety Pamphlet No. 2, Alabama Operators Association, prepared by Jas. L. Davidson, secretary, under the approval and direction of the Mine Casualty & Mining Institute Committee.

Having noticed in the Alabama Supreme Court Reporter a decision, awarding heavy damages to the administrators of a man killed in the mines by gas from the exhaust of a compressed air driven pump, when he went to start up the pump; the secretary takes the liberty of giving you the following information, gathered from reliable sources, in regard to the care and operation of air compressors, with respect to safety and efficiency, viz:

It is a fact that air compressors frequently pollute the mine air with dangerous gases, and sometimes explode, causing damage to persons and property. In either case the same may be generally attributed to the excessive heating in the presence of compressed air of the oil and foreign substances that have collected in the cylinder, discharge pipes and air passages and especially in and around the valves. Volatilization and ignition of oil and other carbonaceous matter occurs very rapidly in the presence of highly heated air.

The greatest heating takes place where the air passes from the cylinder into the discharge pipe.

Even though the compressor is equipped with modern and approved cooling devices, insufficiency of size or too many angles in the discharge pipe, or incrustation of dust mixed with oil, at the discharge opening, decreasing the capacity of the discharge any or all of them may produce enough heat to cause an explosion, or anyway, produce dangerous gases, which should not enter the mine.

It is therefore, important:

First. To keep the compressed air, while being compressed, at as low a temperature as possible.

Second. To prevent oil and other carbonaceous substances from collecting in any part of the machine or in the discharge pipes.

All ports and air passages should be as large as practicable and should be kept free from obstructions and incrustations. In addition to partly closing the ports, incrustation often causes the valves to stick resulting in disastrous consequences.

To avoid incrustation and collecting of oil and foreign substances in the machine and discharge pipes, high grade non-carbonizing oil may be used and should be properly fed into the cylinder. Petroleum oil, especially free from volatile carbon, with flash point of not less than 625 degrees F. is recommended. The oil should not be too dense nor contain animal or vegetable oil. Do not, in any case, use ordinary steam cylinder oil. Why? Because the heat in the steam cylinder is moist, and the surplus oil is washed out, whereas, the heat in the compressor cylinder is dry, thus causing the oil to stick and cake. For the above reason, and also on account of the difference in the character of the proper lubricant and the work it has to perform, the proper feeding of

oil to the compressor cylinder, is very different from the oil fed to a steam cylinder. Too much oil causes incrustation. A surprisingly small quantity of good oil will give sufficient lubrication to air compressors. Watch your compressor and cut the amount of oil down to the minimum of its requirements. Oil should not be allowed to collect in the machine. In case it does, it should not be allowed to remain, but should be drawn off immediately.

Even when using the best oil, properly fed to the cylinder, the machine should be cleaned frequently or when needed.

Do not use kerosene for cleaning! It is very dangerous. Kerosene has a flash point of about 120 degrees F. and the temperature of the compressed air may at any time reach 300 to 450 degrees F. and cause an explosion. The best and safest method of cleaning is to feed into the air cylinder, soapsuds, made of one part soft soap to 15 parts clean water. Feed a liberal amount of this solution into the cylinder instead of the oil for a few hours or even for a day, if necessary. The accumulation of this water and oil should be drained off from time to time during the process by opening the blow off valve at the receiver.

To prevent rusting, it is necessary to run the machine and feed oil into the cylinder for an hour or so after the cleaning process is completed and the water drained off, so that the valves and all parts connected with the cylinder will become coated with oil before shutting down the machine.

The temperature of the discharged air should never exceed 250 degrees F. The machine should be watched and if the temperature exceeds the above it should be shut down and cooled. If possible the cause of overheating should be eliminated before starting up again.

The temperature increases as the pressure increases; therefore it would be well to equip all air compressors with an automatic pressure or temperature regulator, which will allow the compressor to run idle as soon as the pressure or temperature in the receiver reaches a predetermined limit and likewise bring the compressor into action again as soon as the pressure or temperature falls below this limit. There are regulators on the market which apply to compressors coupled direct to the engine, driven by electric motors, by belt or otherwise.

As an extra precaution a fusible plug may be placed in the discharge pipe near the compressor. This plug should be made to fuse and blow out at a temperature of between 325 and 350 degrees F.

Proper construction, proper care of the machine, high grade lubricants, may save life, and are cheaper than shut downs, lost power, property destroyed, damage suits.

NEW BOOK

Air Compression and Transmission. By H. L. Thorkelson, Associate Professor of Steam and Gas Engineering, University of Wisconsin. McGraw-Hill Book Company, New York. 219 pages 6 by 9 inches, 144 cuts, various tables, etc. Price \$2.00.

This book follows closely the lines indicated by its title. It has nothing to do with the various applications and employments of compressed air, which leaves an opportunity for a succeeding volume. The principles involved in practical air compressing are elucidated, the various compressing systems are described and illustrated, also the means for measuring air in use, the speeds of transmission, pipe capacities, etc. The book is not all original, but the sources are generally indicated.

SHOP VENTILATION AND DUST COLLECTION

The following orders are put out by the Industrial Commission of Wisconsin.

EMERY WHEELS.

All grinding, buffing and polishing wheels, except wheels where water is applied at the point of grinding, must be equipped with a hood. The hood must cover the wheel in such a manner that it will carry off the dust insofar as the character of the work will permit. On grinding, buffing or polishing wheels 4 in. or less in width, the width of hood must be 6 in. On grinding, buffing or polishing wheels over 4 in. in width the maximum width of hood must never be less than 2 in. nor more than 3 in. wider than the width of the wheel.

The suction in the connection to the hood must be sufficient to displace a column of water in a U-tube, 5 inches. The test for suction with the U-tube must be a static test and must be made in the following manner: A hole $\frac{1}{8}$ in. in diameter must be made in the suction pipe approximately 12 in. from the connection to the hood. The rubber hose at-

tached to the U-tube must be placed over the $\frac{1}{8}$ -in. hole and the test made under these conditions. When the water in the U-tube stands at 0, the 5-in. displacement is secured when one column of water rises $2\frac{1}{2}$ in. above 0 and the other column of water falls $2\frac{1}{2}$ in. below 0.

All branch suction pipes must enter the main pipe in the direction of the flow of air and at an angle not exceeding 45 deg. measured from a line drawn parallel with the current of air in the main suction pipe. All bends, turns and elbows in suction and discharge pipes must be made with smooth interior surfaces and the radius of the curvature of the elbows on such pipes, measured from the center of the pipe, must not be less than twice the diameter of such elbows.

The dust discharged from any exhaust system must be taken care of by a dust collector, air washer or other adequate system which will prevent it from contaminating the air in or around the place of employment.

SANDBLASTS.

All sandblasting operations, not performed under an inclosed hood, must be performed in a special room set aside for that purpose. This room must be equipped with an exhaust system which shall change the air in the room not less than four times per min. The employer must furnish the employees who are working in sandblast rooms with a suitable covering for the face, which will protect the eyes, nose and mouth; such protector should be worn by the employee when working in the sandblast room. All tumbling barrels and ratters must be equipped with an exhaust system, which will remove all particles of dust which are light enough to float in the air. All machines which create and throw off dust sufficiently light to float in the air, must be equipped with an exhaust system so designed and attached that it will carry off the dust insofar as the character of the work will permit.

FORGES, FOUNDRIES, ETC.

All furnaces and forges which emit gas or smoke in such quantity as to be irritating, obnoxious, or injurious to health, must be equipped with a ventilating system which will remove as much of the gas and smoke as the character of the work will permit. In all places of employment where the heat or humidity, as a result of the work done, is such as

to be injurious to health, a means of ventilation must be provided which will reduce the heat or humidity to as reasonable a degree as the nature of the work will permit. Where the air is so dry that it is injurious to the health it must be properly humidified.

All foundries, forge shops, round-houses and other places of employment in which smoke, gas, dust or vapors are present in sufficient quantities to obstruct the vision, or to be irritating, obnoxious, or injurious to the health, must be equipped with a system of ventilation which will eliminate such smoke, gas, dust or vapors, insofar as the conditions of the industry will permit.

Such system of ventilation must change the air in the room not less than twice each hour, and must supply the room with an additional amount of air to make up for the loss of oxygen which is consumed by the fires. Each person in the room must be supplied with not less than 1,800 cu. ft. of fresh air each hour. The above standard of ventilation for foundries and forge shops can be secured with proper window space on the sides, sufficient height of roof, and with adequate lantern provisions in the roof.

CUBIC FEET OF AIR REQUIRED.

All rooms in places of employment where there is less than 900 and more than 300 cu. ft. of air space per person, and in which there is no smoke, gas, fumes, dust, vapors, or fires consuming oxygen, must be provided with a ventilating system which will furnish 1,800 cu. ft. of fresh air per hour to each person. In all rooms specified above, where there are lights or fires which consume oxygen, an additional amount of air must be supplied to make up the loss of oxygen.

All rooms in places of employment where there is 900 cu. ft. of air space per employee, and in which there is no smoke, gas, fumes, dust, vapors, or fires which consume oxygen, must be provided with a ventilating system which will change the air in the room not less than twice each hour. Such system must be so designed as not to produce injurious drafts or reduce the temperature materially below the average temperature maintained.

It has been found that in rooms where the employees are engaged in active work, a temperature of 60 to 65 deg. is the best standard to maintain. In this temperature the men are invigorated and are less likely to catch cold

when they go out of doors. In rooms where the employes are engaged in sedentary occupations, it has been found that a minimum temperature of 68 deg. is advisable.

In all places of employment not less than 300 cu. ft. of air space must be provided for each person.



FIG. 1. PNEUMATIC HYDRAULIC HOISTS.

PNEUMATIC HYDRAULIC JACKS

The Watson Stillman Company, 50 Church St., N. Y., the well known manufacturers of hydraulic lifts, jacks, presses, etc., are putting out an interesting line of portable pneumatically operated hydraulic lifting jacks especially for railroad shops. As these shops have a working supply of 80 to 100 lb., connection may be had by hose anywhere, the air operating a pneumatic motor which is a part of the



FIG. 2.

equipment, this motor driving a pump which supplies the water pressure by which the lift is actually made, with a positive movement and the concentrated force which the air could not give. These jacks are made in various styles and sizes. Fig. 1 shows a telescopic jack with a lift of 7 ft., while Fig. 2, also telescopic, work in places where the vertical space is limited.

PRECAUTIONS AGAINST GAS ACCUMULATIONS IN TUNNEL DRIVING

Large quantities of gas were encountered during the cutting of the aqueduct tunnel, 19,560 ft. long, through the Santa Ynez range (California) for the water supply of Santa Barbara, and in order to dispose of this inflow, electric arcs were used to ignite the gas after firing shots in the heading. Specially designed open lamps were placed about 200 ft. apart in high points along the tunnel up to 150 ft. from the heading. Half an hour after blasting the arcs were switched into circuit (an ammeter at the switch indicating whether the arcs lighted or not). After switching on the lamps controlled from the tunnel mouth, the foreman and a mate advanced to another arcing station 3,500 ft. from the portal, and again switched on current. If no gas explosion occurred, the tunnel ahead was explored with safety lamps, and if no "pockets" were discovered, the inspectors returned to the in-by station, switched the arcs into circuit, and,

leaving them alight, proceeded to the heading and placed torches at intervals of 100 ft. through the gas section. These torches were kept burning during the next shift, and four hours were occupied in testing before a heading gang was allowed to go on shift after blasting had been performed.

NOTES

The Ingersoll-Rand Company, at its annual meeting April 29, elected President W. L. Saunders chairman of the Board of Directors, a new position. George Doubleday, formerly first vice-president, was elected president. W. R. Grace was made first vice-president and treasurer. George R. Elder was re-elected vice-president and J. P. Grace and Henry Lang were made vice-presidents. F. A. Brainerd was re-elected secretary.

A "note" at page 6828 in our issue for May, reproduced without proper scrutiny from a respectable exchange, stated that a cubic yard of granite weighs exactly three-quarters of a ton, which is absurd. The average weight of a cubic foot of granite is 170 pounds, which would make the weight of a cubic yard 4,590 pounds.

It is estimated that the automobile factories of the United States have been using 3,000,000 gallons of gasoline a year for testing their motors, and that by substituting illuminating gas for this service they will save \$1,750,000 a year.

Modern blast-furnaces consume about 40,000 cu. ft. of air per minute, and for each grain of moisture per cubic foot, there enters the furnace 1 gal. of water per hour for each 1,000 cu. ft., that is, if the moisture was 1 gr. per cubic foot, 40 gal. of water would enter the furnace per hour.

The building of the aqueduct from the Catskills to New York has cost many lives. Since the first pick was swung 200 men have been killed and 3,800 injured, most of the accidents being the result of dynamite explosions. At the present time there are about 11,000 men employed.

With \$330,000,000 in subway contracts, a few million more for third tracking and replacing elevated structure, \$89,000,000 for the New

York Central west side improvements, \$15,000,000 for docks, besides the regular city street and building improvements, New York promises to be the mecca and happy stamping ground for contractors for some years to come.

Plans have been filed at Ottawa for a \$1,000,000 tunnel under the business section of Vancouver. It will be single track, 19½ feet high, 16 feet wide, 3,800 feet long; average depth below surface, 35 to 40 feet.

Canaries have proved to be the most sensitive animal test of the safety of mine air after explosions. In recent experiments, air containing 0.16 per cent. of carbon monoxide was breathed by a mouse for an hour before effects were seen, but a canary showed distress in three minutes and fell from its perch in eight. Some miners already carry these birds.

Oxyhydrogen-flame working under water is said to be accomplished successfully by means of a special form of burner recently invented. This burner consists of an ordinary oxyhydrogen burner with the addition of a bell or hood shielding the gas orifice from the water, and a compressed air supply. A bar of iron 2½ in. square was cut through in 30 sec. at a depth of 16 ft. under water, a 12-in. slot was cut in 13-16-in. plate in 1½ min., etc.

Air as the atomising agent for liquid fuel seems to be replacing steam. It is less convenient to use than steam, but at sea steam runs away with so much water that the make up cost becomes heavy. Steam is believed by some to have a beneficial effect on the combustion of hydro-carbons, but very little that is definite seems to be available. The use of air generally demands an air compressor and a pressure of about 20 lb. or 25 lb. But some systems seem to work with a pressure of only three or four pounds.

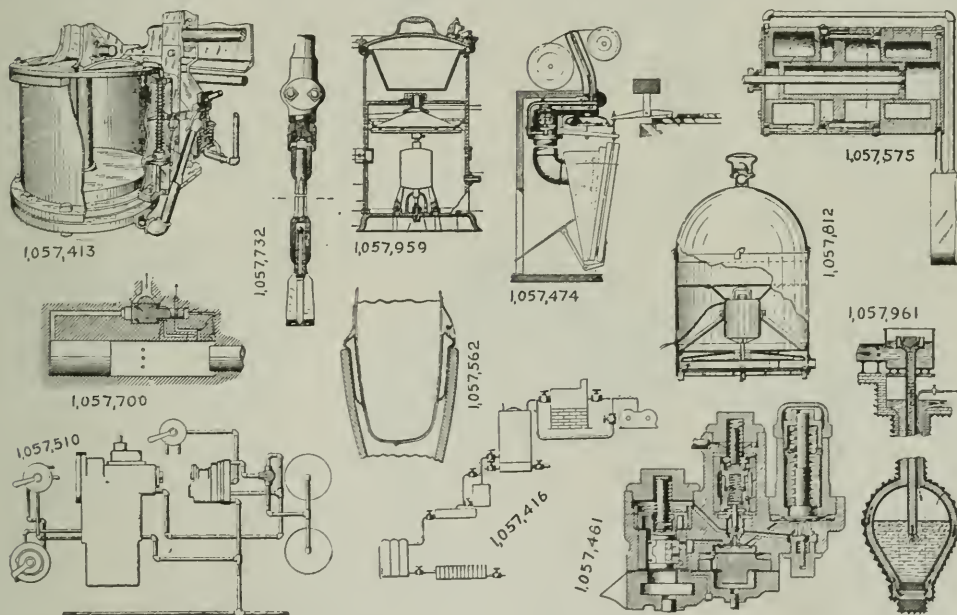
A water power plant with a head of 5,412 feet, more than a mile, is under construction near Martigny, Switzerland. Water is taken from Lake Tully; this is near the valley of the Rhone, where the mountain sides descend precipitously all the way to the river. The pipe line will be 2¾ miles long, with inside

diameters of $19\frac{11}{16}$ in., and $25\frac{5}{8}$ in., with thicknesses of from $\frac{15}{64}$ in. to $1\frac{15}{32}$ in. The upper section will be of lap-welded pipe, while the lower sections will be of seamless drawn tube. The construction of the pipe line has been placed with Thyssen & Co. Turbines, for 15,000-hp. capacity, will be built by Piccard, Pictet & Co., of Geneva.

The Linde Air Products Company, an Ohio corporation, has purchased a site at East Seventy-second street and the Lake Shore Railroad in Cleveland, where it plans to begin shortly the erection of a plant on which about \$150,000 will be spent for buildings and equipment. The company will manufacture oxygen in tanks for use in cutting and welding by the iron and steel trade. The parent organ-

ization has several plants now in operation in various cities and others under construction. It is stated that in addition to the Cleveland plant new factories will be built this year in Boston, St. Louis and Atlanta.

Canadian railways are building or are about to build some important tunnels. There is the tunnel through Mount Royal for an entrance to Montreal, and the $5\frac{1}{2}$ mile tunnel through the Selkirk mountains on which bids were recently opened by the Canadian Pacific Company. But these are small pieces of work as compared with the 15-mile tunnel through Kicking Horse Pass in the Rocky Mountains, which, according to press dispatches, will be placed under construction in the near future by the Canadian Pacific.



PNEUMATIC PATENTS APRIL 1.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

APRIL 1.

- 1,057,413. DUMP-CAR DEVICE. CHARLES H. DOTY and WILLIAM L. BURNER, Columbus, and JOHN M. WILCOX, Cleveland, Ohio.
 1,057,416. PROCESS OF CONCENTRATING SULFITE WASTE LIQUOR. CARLETON ELLIS, Montclair, N. J.
 1,057,474. PNEUMATIC ACTION FOR MUSICAL INSTRUMENTS. MORRIS S. WRIGHT, Worcester, Mass.
 1,057,481. SYNCHRONOUS PRESSURE-CONTROLLING DEVICE. CLYDE C. FARMER, Chicago, Ill.

1,057,497. HIGH-SPEED BRAKE APPARATUS. ROBERT A. PARKE, Parke Mines, Ontario, Can.

1,057,509. COMBINED AUTOMATIC EMERGENCY AND INDEPENDENT BRAKE APPARATUS. WALTER V. TURNER, Edgewood, Pa.

1,057,519. PROCESS OF PRESERVING MILK. CHARLES H. ATKINS, Springfield, Mass.

The process for preserving and handling milk which consists in freely pouring into a container open to the atmosphere a quantity of milk of less volume than the capacity of the container, then closing the container and introducing therein air under sufficient pressure to provide and maintain an excess air-pressure within the container, then subjecting the sealed container and contents to a sufficiently high temperature for a sufficient length of time to prevent the subsequent development of living organisms therein, and finally removing the liquid contents of the

container while in an inverted position whereby the excess air-pressure will insure the complete expulsion of the entire liquid contents and still leave the container wholly filled with sterile air to maintain the inside walls of the container sterilized for refilling purposes.

1,057,562. PNEUMATIC CUSHION FOR STUMP-LEGS. JOSEPH G. LA POINT, New Albany, Ind.

1,057,575. AIR-COMPRESSOR. EDWARD MURPHY, Ennis, Tex.

1,057,700-1. VALVE-MOTION FOR PERCUSSIVE TOOLS. LEWIS C. BAYLES, Easton, Pa.

1,057,732-3. ROCK-DRILL. CHARLES C. HANSEN, Easton, Pa.

1,057,812. VACUUM-CLEANER. JOHN J. DUFFIE, San Francisco, Cal.

1,057,959. VACUUM-PUMP. WALTER A. HEARN, Baltimore, Md.

1,057,961. HYDRAULIC AIR-COMPRESSOR. CARL HEIRICH, Cologne, Germany.

1,058,491. AIR-COMPRESSOR FOR BLOWING ORGANS. HUGH SWANTON, Philadelphia, Pa.

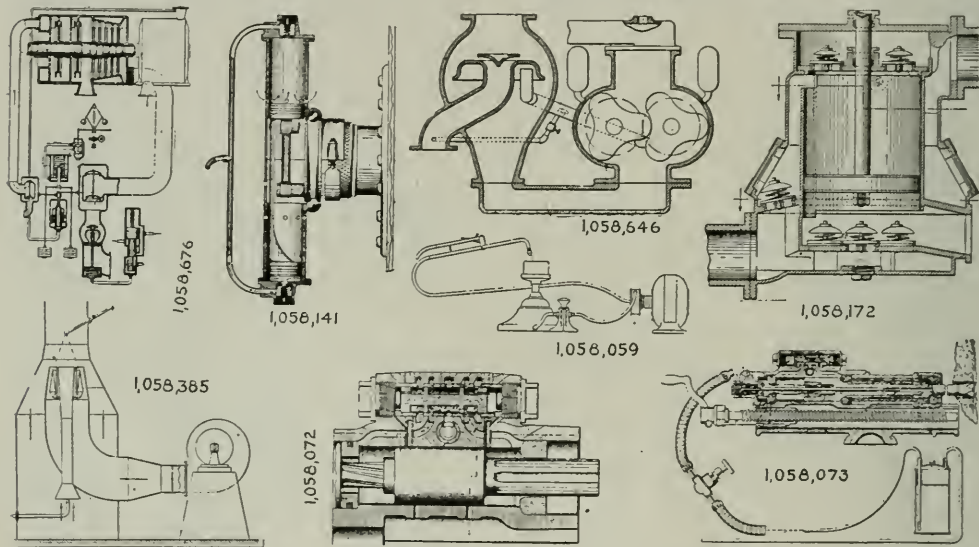
1. An air compressor for blowing organs comprising a series of spaced, separate rectangular fan casings, adjacent casings, having communication with one another, a connecting chamber of rectangular configuration for establishing such communication, one end casing having an air inlet port therein, and the other end casing having an air outlet port therein, a fan operative within each casing and a non-conducting sound screen of corrugated porous material operatively fitted across the respective ports.

1,058,646. CONDENSER AIR-PUMP. ROYAL D. TOMLINSON, Milwaukee, Wis.

1,058,676. TURBO-COMPRESSOR-GOVERNING MECHANISM. JEAN ALEXANDRE REY, Paris, France.

APRIL 15.

1,058,706. SHEET-FEEDING MECHANISM. WILLIAM S. AMIDON, Milwaukee, Wis.



PNEUMATIC PATENTS APRIL 8.

APRIL 8.

1,058,059. APPARATUS FOR CASTING METALS. GEORGE A. HOWE, Pittsburgh, Pa.

1. In apparatus of the character described, an investment holder, a blow-pipe, and means intermediate said parts and connected thereto for supplying air under pressure to the blow-pipe, said means receiving its air supply through the investment holder or independently thereof at will.

1,058,072. ROCK-DRILLING ENGINE. JOHN GEORGE LEYNER, Denver, Colo.

1,058,073. WATER-CONVEYING APPARATUS FOR EJECTING ROCK-DRILLINGS FOR ROCK-DRILLING ENGINES. JOHN GEORGE LEYNER, Denver, Colo.

1,058,074. VALVE MECHANISM FOR ROCK-DRILLING ENGINES. JOHN GEORGE LEYNER, Denver, Colo.

1,058,136. PRESSURE-RETAILING MECHANISM FOR FLUID-PRESSURE BRAKES. CLAUDE A. BAKER, Mitchell, Ind.

1,058,141. PUMPING ATTACHMENT FOR AUTOMOBILES. OSCAR M. BERGSTROM, Minneapolis, Minn.

1,058,172. AIR-PUMP. BURT O. GAGE, Warren, Mass.

1,058,335. MECHANICAL DEVICE FOR CREATING FORCED DRAFT. JULES PRAT, Paris, France.

1,058,817. STATION-INDICATOR. HOMER S. VOTAW, Laurier, Wash., and HARRY GLENN COULSON, Portland, Ind.

1. In an indicator of the class described, a ribbon, spaced drums on which said ribbon is oppositely wound, means for oppositely and independently rotating the drums, said means including a cylinder, a fluid operated piston contained in said cylinder and operatively connected to the drums, an exhaust tube for the cylinder having an enlarged end, a valved connection controlling the supply of fluid to the cylinder, an inclosed piston connected with the valve, a port connecting said inclosure and enlarged end of the exhaust tube whereby the exhaust will cause a suction in the piston inclosure last mentioned tending to close the supply valve and means for admitting fluid behind the last mentioned piston to shift the same and close the valve carried thereby.

1,058,847. PNEUMATIC MOTOR. WILLIAM F. COOPER, Norwalk, Ohio.

1,058,900. CACTUS-BURNER. ALEX PLOCH, Carpenter, Tex.

1. In a cactus burning device comprising a liquid fuel tank, means for supplying air under pressure to the tank, a discharge pipe for the tank, means for controlling the flow through the discharge pipe, a pipe of resilient metal secured on the end of the discharge pipe and having a plurality of elongated loops, a transversely

extending burner secured to the end of the loops, and having a discharge aperture formed in one side thereof, and a frusto conical shield member frictionally engaged on the loops.

1,059,033. FLUID-CONTROL SUPPLY-VALVE FOR FLUSH-TANKS. EDWARD G. COOK, New York, N. Y.

1. In a device of the character described, a tank, a water inlet pipe in the tank, a cylinder at the upper portion of the tank, a piston working in said cylinder, a valve seat in the water inlet of the cylinder, a valve controlling said seat, means connecting said valve with said piston whereby the movement of the piston will open and close the valve, and a conduit leading from the said cylinder between the closed end and said piston down through the tank with its extremity open and located a considerable distance below the water line of the tank, whereby the rise of the water in the tank will compress the air in the conduit and cylinder to advance the piston and close the said valve when the water reaches a certain pre-determined level.

1,059,035. SAND-PUMP. ALBERT V. STEELE, Bedford, Ind.

1,059,423. PNEUMATIC COUNTERSINKING-MACHINE. JAMES H. BONDY, Great Falls, Mont.

1,059,539. ROCK-DRILL. CHARLES A. HULTQUIST, Bisbee, Ariz.

1,059,549. PNEUMATIC ACTUATING UNIT. NELS MAGNUNSON, Fort Wayne, Ind.

1,059,563. WATER ATTACHMENT FOR DRILLING-MACHINES. CHARLES B. RICHARDS, Cleveland, Ohio.

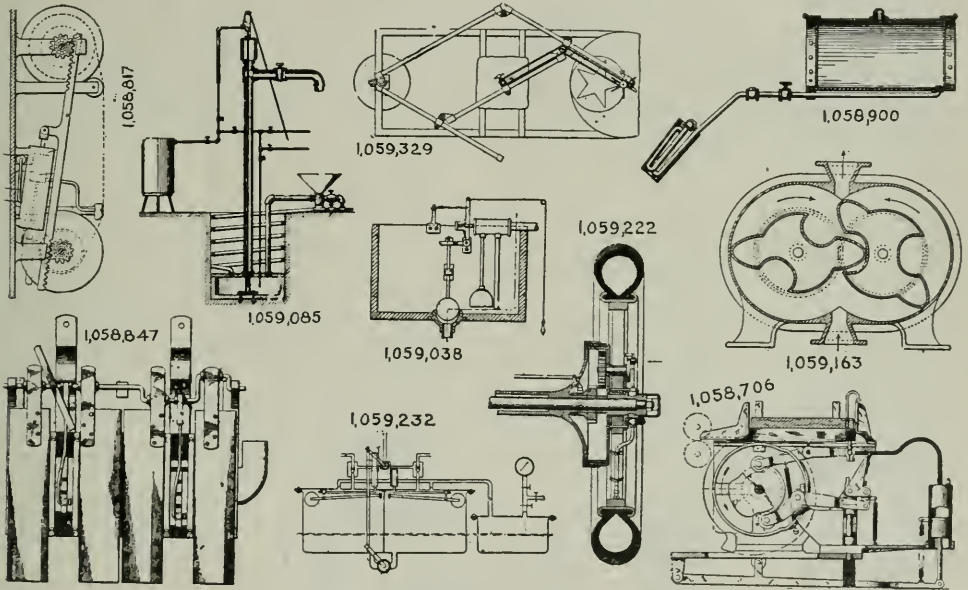
1,059,584. APPARATUS FOR DECOMPOSING OXIDS OF NITROGEN AND THE LIKE. PAUL WINAND, Cologne, Germany.

1,059,645. PNEUMATIC CARPET-CLEANER. LOUIS F. ST. ANTHONY, Worcester, Mass.

1,059,658. PNEUMATIC STACKER. GEORGE F. CONNER, Port Huron, Mich.

1,059,661. MANUFACTURE OF PORTLAND CEMENT. THOMAS A. EDISON, Llewellyn Park, Orange, N. J.

5. The process of manufacturing Portland cement, which consists in fusing silicious and aluminous materials with limestone in such proportions as to result in fusion at a temperature less than 2500 degrees Fahr. and the production



PNEUMATIC PATENTS APRIL 15.

1,059,161. BLADE FOR THE WHEELS OF ROTARY FLUID-COMPRESSORS. ALBERT HUGUENIN, Zurich, Switzerland.

1,059,163. ROTARY BLOWER. ALEKSANDER JENDRUSIK, Dabrowa-Gornicza, Russia.

1,059,207. PNEUMATIC TIRE AND ARMOR THEREFOR. JAMES A. POSEY, Waxahachie, Tex.

1,059,222. AIR-PUMP. CHARLES MACK SCOTT, San Angelo, Tex.

1,059,232. HYDRAULIC COMPRESSOR. GUSTAV SUDA, Vienna, Austria-Hungary.

1,059,324. PNEUMATIC ATTACHMENT FOR PIANOS. WILLIAM A. WATSON, Medford Hillside, Mass.

1,059,329. BLOWPIPE APPARATUS. WORTHY C. BUCKNAM, Jersey City, N. J.

APRIL 22.

1,059,367. METHOD OF AND APPARATUS FOR BESSEMERIZING COPPER MATTE. HOWARD B. JERNEE, Perth Amboy, N. J.

1,059,373. SPRAYING DEVICE. WILLIAM T. KING, Minneapolis, Minn.

of an extremely liquid non-viscid slag containing approximately 50 per cent. of lime, in subjecting the fluid slag to a powerful blast whereby it will be chilled and finely subdivided, in adding sufficient limestone to complete the final proportion of lime desired for the cement, and in finally calcining the mixture, substantially as set forth.

1,059,802. CENTRIFUGAL FAN. EUGENE B. WILLIAMS, Boston, Mass.

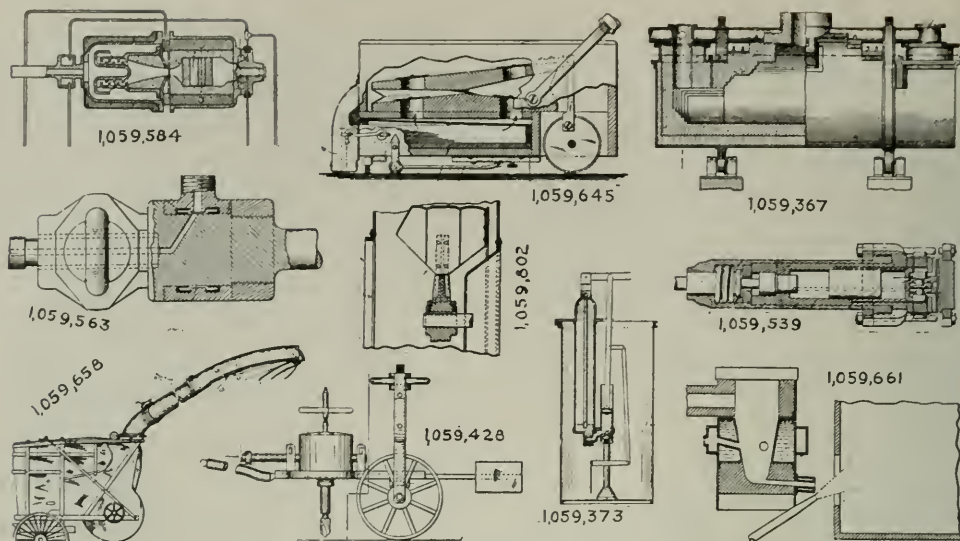
APRIL 29.

1,059,976. SYSTEM FOR PURIFYING, HUMIDIFYING, AND CONTROLLING THE HUMIDITY OF AIR. WILLIS H. CARRIER, Buffalo, N. Y.

1,060,012. FLOAT-VALVE FOR CENTRIFUGAL COMPRESSORS. FRED E. NORTON, Lynn, Mass.

1,060,030. VALVE STRUCTURE. JOSEPH SCHWERTNER, New York, N. Y.

5. A pneumatic valve structure for musical instruments or the like, comprising a relatively fixed member and a relatively movable member fulcrumed thereto intermediate their ends, and a



PNEUMATIC PATENTS APRIL 22.

flexible membrane extending from one member to the other to form a bellows on each side of the fulcrum, one bellows being larger than the other whereby with the same pressure in both the larger bellows will predominate, both of said bellows being tapered off along both members away from the fulcrum.

1,060,102. METHOD OF CONVEYING WARM LIQUIDS. HEINRICH KOPPERS, Essen-on-the-Ruhr, Germany.

1,060,125. FLUID-OPERATED ENGINE. ENOCH RECTOR, New York, N. Y.

1,060,127. VALVE FOR JARRING-MACHINES. ROBERT FRANKLIN RINGLE, Zellenopole, Pa.

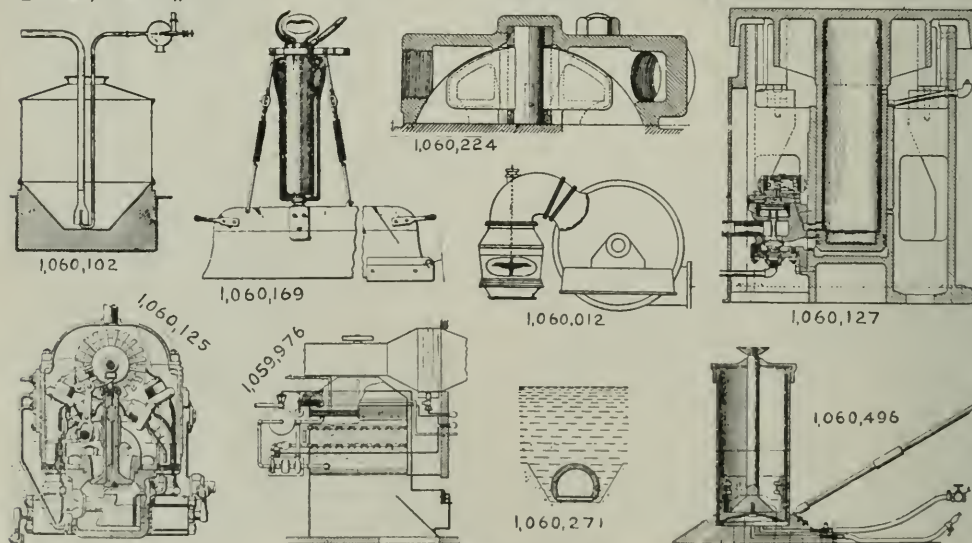
1,060,169. PNEUMATIC HOG AND CATTLE SPLITTER. EMIL DEMOULIN, National City, Ill.

1,060,224-5. PERCUSSIVE TOOL. LEWIS C. BAYLES, Easton, Pa.

1,060,271. METHOD OF BUILDING SUBAQUEOUS TUNNELS. DUNCAN D. McBEAN, New York, N. Y., and HENRY M. CHANCE, Philadelphia, Pa.

1. A method of constructing subaqueous tunnels which consists in building the main body of such tunnel, or the main body of a section thereof, at the surface so constructing said structure as to permit of its use as a working chamber adapted to retain air under pressure; floating said structure into place and sinking it into the desired position upon the proposed site of the tunnel and maintaining air under pressure in said structure, whereby a working chamber is formed which is bounded by the inner surfaces of said structure and by the surface of the material upon which the tunnel is to be constructed, and completing the construction of said tunnel, or of said section thereof.

1,060,496. COMPRESSED-AIR JACK. LOUIS J. ROUGHLEAU, Arlington, Cal.



PNEUMATIC PATENTS APRIL 23.

COMPRESSED AIR

MAGAZINE

EVERYTHING PNEUMATIC.

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FIG. 1. MAIN BUILDING AND POWER HOUSE, CAMERON PUMP WORKS.

A MODERN PLANT FOR BUILDING PUMPS

BY CHAS. A. HIRSCHBERG.

To take care of the ever increasing demand for its product, the A. S. Cameron Steam Pump Works recently erected a new shop, at Phillipsburg, N. J., which is typical of modern practice, in shop construction.

Many novel features are to be found in this plant, and it is the object of this paper to describe these, as well as the characteristic features of design contained in the Cameron product.

The Cameron Works have grown from a small one-room shop, started in 1860, located at the corner of 22nd St. and 2nd Ave. in the City of New York, embracing approximately 400 square feet of floor space, to its present extensive modern quarters, giving employment to many men in different departments and providing for future growth and development.

It is interesting to note the growth attendant upon the manufacture of a product greatly limited in its early scope, to one that is now found as an accessory to many other mechanical contrivances in various fields. This product has earned a world-wide reputation for quality and efficiency and it is obvious that true merit alone could be responsible for such growth, both in plant, and the recognition accorded the

product as the standard line of pumps, for mining, contracting, boiler plant, sugar industry and general industrial and manufacturing purposes.

As already stated, it was in 1860 that the A. S. Cameron Steam Pump Works was founded, by Adam Scott Cameron.

In 1863 Mr. Cameron formed a partnership with William Sewell, at that time a Chief Engineer in the U. S. Army, and together, they produced what was then known as the Sewell & Cameron Crank and Flywheel Pump. This pump met with such great demand that it became necessary to increase the size of the plant at that time. In 1865 the partnership was dissolved by the death of Mr. Sewell and the business continued under the direction of Mr. Cameron.

That year saw the advent on the market of a new pump, namely, a crank and flywheel dry vacuum pump, used in connection with the process of sugar boiling. Remarkable economies were effected with this pump, over the former methods and means used in the sugar industry.

In 1868 it again became necessary to seek larger quarters, and the plant was accordingly moved to a three-story building at the foot of East 23rd St. This building had a frontage of 100 feet and was 200 feet deep.

About this time experiments were completed by the Cameron Works on a double-acting, Horizontal, Piston Simplex Pump, embodying a distinct departure from all contemporary design, in that there were no outside moving parts, but the entire operation of the pump was controlled by an enclosed steam thrown valve. Its simple design, rugged, fool-proof construction and efficient operation, appealed so strongly to users of pumps, that it became an immediate favorite, and was largely adopted as a boiler feeder in power plants, for pumping oil in the oil fields, and general mine service.

This type, in fact, became the nucleus for a line of pump types, largely responsible for the popularity of the Cameron. Among these may be mentioned the long stroke pattern, for rolling mills and blast furnace service, a special oil-line pattern, for the oil fields, and which design embodies a removable bushing; a vertical piston pattern, for shaft sinking and a horizontal plunger pump, for handling gritty water in mine station work. These and many others were built around the first original design, each embodying its best features, with modifications, to meet the various service to which each was to be applied.

In 1877 Mr. Cameron's death occurred, due to gradually failing health. To this date the business had grown to such proportions that several additional buildings were required, until the whole plant covered a plot of ground 325x200 feet, occupying nearly three-quarters of the block bounded by 23rd and 24th Sts. and Ave. A and 1st Ave., in the City of New York.

The business was continued under the administration of the Cameron Estate. Many new types of pumps were added to the line, notably, the vertical plunger pattern, for shaft sinking, a recognized leader to-day for this class of work.

Frequent installations of new and improved shop machinery were made and additional space secured, but in 1910 the business had far out-grown the manufacturing facilities and it was decided to erect the new and modern plant now located at Phillipsburg, N. J.

The Phillipsburg Plant shown in Fig. 1 consists of one main building, 100 feet wide by 600 feet long and a number of auxiliary buildings. The main building is of the Central Bay type, and is 50 feet wide at this point, while the wings are each 25 feet wide. The main bay is

traversed by a ten ton Shepard Electric Crane, taking current from a side trolley. In addition to this large Crane, there are a number of small three ton traveling Cranes, equipped with electrically operated hoists, operating in the wings. Fig. 2 shows a view of the Central Bay as well as the Shepard Traveling Crane. The moving proposition in this plant is a comparatively simple and easy one, due to the splendid provision made, and hand trucks are but very little required.

The building itself is of structural steel, brick and concrete, and, as will be noted from the illustrations, is particularly well lighted at the roof and sides. This is further augmented by the white painted walls and steel work.

At the front end of the building is located the factory office, occupied in part by the general force and by the Engineering Department. This is also shown in Fig. 2, while Fig. 3 is a view in the Engineering Department.

In the left wing is situated an especially well equipped tool room, caged off from the rest of the shop and with provisions for growth for some time to come. This is shown in Fig. 4. In this wing is also located the brass room shown in Fig. 5, where all work, embodying the use of such metal, is performed.

Beyond this is located the main erecting floor, with its accompanying tool benches and laying out tables. The entire shop is piped with compressed air and there are a number of uses to which this power is put in the Erecting Department. Among the pneumatic tools employed are found chipping hammers, Little David Pneumatic Drills, and various pneumatic testing appliances. Compressed Air is largely used for cleaning castings as well as operating tools. Fig. 6 shows the Erecting Department.

A rather novel application of a pneumatic drill is shown in Fig. 7. All studs are seated in the cylinders by means of such tools, effecting considerable economy over the hand ratchet stud seating tool, generally employed. Fig. 6, already referred to, shows a number of light swinging arms and trolleys which are employed in connection with these drills. The tool is suspended by means of a wire rope and small pulley, with a counterbalance weight, making the apparatus easy to handle.

Just to one side of the middle of the Central Bay are located the testing pits, with their

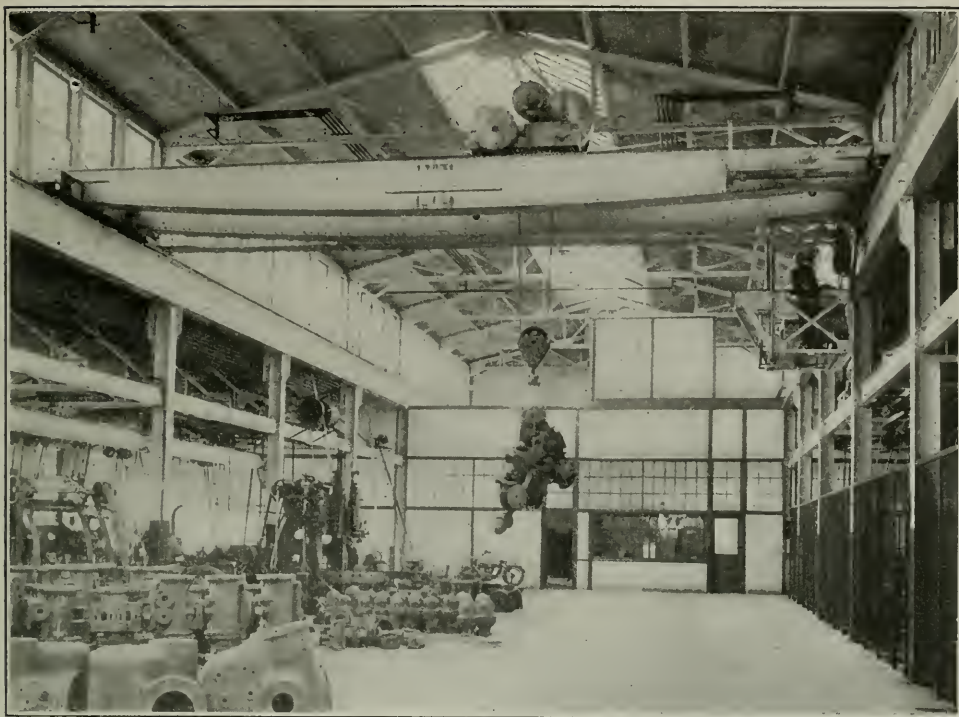


FIG. 2. CENTRAL BAY AND SHEPARD TRAVELING CRANE.

accompanying equipment, of which we will have more to say.

In the right hand wing is the store room, shipping department and lathe department, together with a number of batteries of drill presses and semi-automatic Potter & Johnson machine tools. Fig. 8 shows this department.

Projecting into the main bay are a number of large boring mills and planers, capable of handling the very largest class of pump work.

It will be noted from the illustrations that all the large machine tools are individual, motor driven, whereas, the smaller machine tools are grouped in sets, by classes, and driven from main individual line shafts operated by separate motors. These motors have been installed in a rather novel manner; they are suspended overhead, materially reducing the length of belt drive. Two very important things are gained by this method of installation; first, floor space is saved and left unencumbered by motors and drives; second, the electrical equipment is placed out of harm's way and is readily accessible should occasion require.

In Fig. 9 is shown the locker and wash room located in a supplementary building. The provision made for the comfort of the employees has been given a great deal of thought and here in this room are to be found individual steel lockers, wash basins, supplied with hot and cold water, etc.

Throughout the shop are conveniently located sanitary bubble drinking fountains, the water for which purpose is pumped from an 800 foot deep well, operated by an Ingersoll-Rand Air Lift.

The shop is heated by exhaust steam, and electrically lighted by numerous arc lamps and individual machine tool lamps.

In the shipping department, platform loading has been arranged for. The cars are switched into the building on a sunken track.

The work generally has been standardized by the employment of jigs, so as to insure the interchangeability of parts, while numerous templets and gauges are employed, assuring correct workmanship.

Fig. 10 shows one of these numerous special jigs applied to a boring mill. This jig is em-

ployed for chucking the oddly shaped, centrifugal pump casings. The jig is bolted to the bed plate in the usual manner. Two arms "A" have planed surfaces on which the casting is set. At "B" are located set screws, by means of which the casting is leveled, while at "C" are located dogs by means of which the casting is clamped to the jig, after leveling, and preparatory to facing the casting.

The provision for testing both the direct-acting steam pumps, the centrifugal, motor and power driven pumps is most complete. A 62 feet long by four feet wide, cement lined trench, is provided for testing Cameron Simplex Pumps, with a 30 feet deep well at one

many pumps may be tested at one time, depending, of course, upon their size. Fig. 11 shows several pumps undergoing test and at the top of the picture may be seen the two steam lines, one a high pressure and the other a low pressure, also an air line for testing pumps that are to be operated by compressed air. Provision is made at the boiler for obtaining either high or low steam pressure.

Figs. 12 and 13 show the equipment for testing centrifugal pumps. The maximum testing capacity is 350 horse power.

Three weir tanks are provided, the smallest having sufficient capacity to test pumps up to 4" discharge, the next larger to test pumps up



FIG. 3. CENTRIFUGAL PUMP ENGINEERING DEPARTMENT.

end, for testing the suction lift of the pumps, special connections at the bottom, with control on the surface, being provided to regulate the depth of water in the well, for various suction lifts. The above mentioned trench is connected to a further trench, 6 feet wide, encircling the centrifugal testing plants, so as to take care of the overflow. The capacity of this trench is 44,500 gallons. The steam portion of this testing department is such, that a great

to 6" discharge, while the largest tank has a capacity of 16,000 gallons. The large weir tank presents a unique feature of design in the use of an adjustable weir gate obviating the necessity for changing weirs, when different sized pumps are to be tested. This consists of a swinging weir gate in several hinged sections, which are swung into place as occasion requires. A view of this apparatus is shown in Fig. 12.

Special Torsion Dynamometers, designed for measuring the power transmitted to the centrifugal pumps, is used in this department.

Fig. 14 illustrates this device, which is used to couple the shaft of the driving motor directly to the pump. The ends of the driving and driven shafts are securely coupled together by the shaft "G." This shaft, therefore, has to transmit the power from the one machine to the other and in consequence is subjected to torsion. The shaft referred to is of course designed so that the yield point will not be exceeded.

The various parts attached to the shaft "G,"

the slit "P" in the disc "N" is a small window provided with a fine slit "T."

When the eye at "Q" looks through the slit "P" the slit "T" is seen as a streak of light and the divisions show black on the scale "U." Slit "T" serves as a pointer, indicating the relative motion of the two discs "N" and "O" as compared to the disc "M." The line of vision is perfectly defined by the two slits "P" and "T;" parallax is therefore impossible when reading the scale and the observation is independent of the distance between the scale "U" and the slit "T." It is apparent that when the apparatus is stationary and the shaft is twisted,



FIG. 3. STEAM PUMP ENGINEERING DEPARTMENT.

serve partly to indicate the angle of twist and partly to prevent it from being twisted excessively, due to overloading. For reading the angle of twist, three discs, "M," "N" and "O," have been provided. The disc "M" is fixed to the end "H" of the shaft; "N" and "O" are fixed to the end "F" of the shaft. The disc "O" has a radial slit "P." To the disc "M" is attached a transparent celluloid rim "U" on which divisions are cut. Directly opposite to

the angle of twist will be shown by the movement of the pointer "T" over the divisions on "U." But this pointer and divisions is also visible, when the instrument is running; in fact, they are clearer and more defined than when the instrument is at rest, for while it is necessary to place the eye close to the slit "P" when the instrument is at rest to see the pointer and the scale, it is not necessary to do so when the instrument is in motion, the scale



FIG. 4. TOOL ROOM.



FIG. 5. BRASS SHOP.



FIG. 6. ASSEMBLING DEPARTMENT.

being readable at some distance from the slit "P."

To obtain a permanent impression on the eye the scale is subjected to a strong light.

Since the shaft and the other parts connected to its extremities have no tendency to move, due to the centrifugal force, the readings of the dynamometer are independent of the speed. The instrument can therefore be run at any desired speed, provided no forces are set up greater than can be resisted by the material of which the discs are made.

It will be readily seen from the above description that the results obtained from the dynamometer are very accurate, in determining the horse power input of the pump, and that its action is entirely independent of losses due to belt slippage, etc., when the pump is undergoing a power driven test."

The writer acknowledges his indebtedness for part of the above description, covering the dynamometer, to an article which appeared in the September 5th, 1911, issue of *Power*.

All Cameron Pumps are given a very rigid test and must be up to a fixed standard of efficiency, set by the Cameron Engineers, before they are considered fit for shipment; a complete record of all pumps being kept on file for ready reference. This is just one of the

many refinements that have gone far towards making the Cameron product a recognized standard for quality and efficiency.

From Fig. 15 some idea may be gained of the important part played in this shop by quantity production. It enables the manufacturers to guarantee absolute interchangeability of parts, the very promptest delivery, and at the same time enables them, coupled as this product is, with a superior class of workmanship and material to give the purchaser a high class product at a comparatively low price.

In the foundry shown in Fig. 16 the most up-to-date practice prevails. Pneumatic shakers, rammers, etc., are employed, insuring a superior quality of product.

The power plant is located in a separate building, electrical current being generated by a 125 horse power, Compound, Cooper Corliss Engine, direct-connected to a Crocker-Wheeler D. C. Generator, generating 100 KW., 400 Ampere, the voltage being 250. This generator set alternates with a belt driven Westinghouse D. C. generator of 70 KW., 280 Ampere, 250 Volts capacity, driven by 95 horse power, Fishkill Corliss Engine. At times when the load is heavy both sets are operated.

In the engine room is also located an Ingersoll-Rand Class "NF-1" steam driven air com-

pressor of 179 cubic feet capacity when operated at 200 RPM. Just outside of the engine room is a large vertical air receiver. This equipment furnishes sufficient compressed air for the various pneumatic appliances used throughout the shops.

The boiler plant contains the following equipment: two 130 horse power Sterling Boilers and one 100 horse power Sterling Boiler, each equipped with Jones Mechanical Under-feed Stokers. These boilers are operated in units of two, alternating with the third boiler. The boiler feed pumps consist of two 6x4x6 Cameron Horizontal Steam Pumps and a 10x6½x12 Cameron Vertical Marine Boiler Feed Pump, which are also used alternately, and in addition there is a 6x8x12 Cameron Wet Vacuum Pump. A Cochrane Open Heater is also installed in the boiler room.

Water for power plant and general purposes is piped in from a lake situated just above the plant. Condensed steam is reconveyed to this lake and provision for cooling and salvage made by means of spray nozzles. At the lake is located a 12" Vertical Motor Driven Cameron Double Suction Volute Centrifugal Submerged Pump with a capacity of 4,000 gallons per minute. Figure 17 shows the interior of the power house and Fig. 18 the cooling apparatus at the lake.

In this connection it is fitting that a word or two be said about the line of Cameron Pumps. As already intimated, these pumps find their application in numerous fields, a few of the more prominent installations being illustrated and described in the accompanying half tones and their captions. They range in size from a small boiler feeder weighing 135 lbs., with a daily capacity of 11,000 gallons, to large compound and twin pumps weighing 22,000 lbs. each and having a daily capacity of over four million gallons. In addition to the usual industrial installations may be mentioned the pumping equipments of the five large municipal ferry-boats built by the City of New York, as well as the armored cruisers North Carolina and Montana.

Quite recently the Cameron Steam Pump Works was awarded the contract for a large number of centrifugal pumps for the Panama Canal. These pumps are of the direct-connected to motor, centrifugal type and are used in connection with the hydraulically operated lock machinery, forming a part of the drainage and sump systems of the locks and gates.

Nine were of the 6" Vertical Volute Type for sump drainage, having a normal capacity each of 800 gallons per minute.

Three were 8" vertical Double Volute Pumps, for use in the main culvert, each with a nominal capacity of 4,200 gallons per minute. They were installed to pump the culvert dry, when occasion arose, and to take care of such leakage as occurs from the cylindrical valves and the bulkheads.

Forty-eight pumps on this contract were 5", Two Stage, Turbine Pumps, used in connection with a chain fender, for the protection of certain lock gates. Each of these pumps has a nominal capacity of 1,200 gallons per minute.



FIG. 7. INSERTING STUDS.

The specifications accompanying the call for bids on this equipment were very stringent and took into consideration the design, conditions and climate under which the equipment would operate, as well as such features as proportions and shapes of the water passages, impellers, vanes, outlets and bearings. The order was secured only after keen competition.

The Cameron line of Centrifugal Pumps is built in the Double Suction Volute type, up to 16 inches discharge, giving capacities up to 7,500 gallons per minute, and in the Turbine type, up to 6 inches, four-stage, ranging in capacities up to 1,200 gallons and to 800 feet head. They are also built in the Single Suction Volute type.

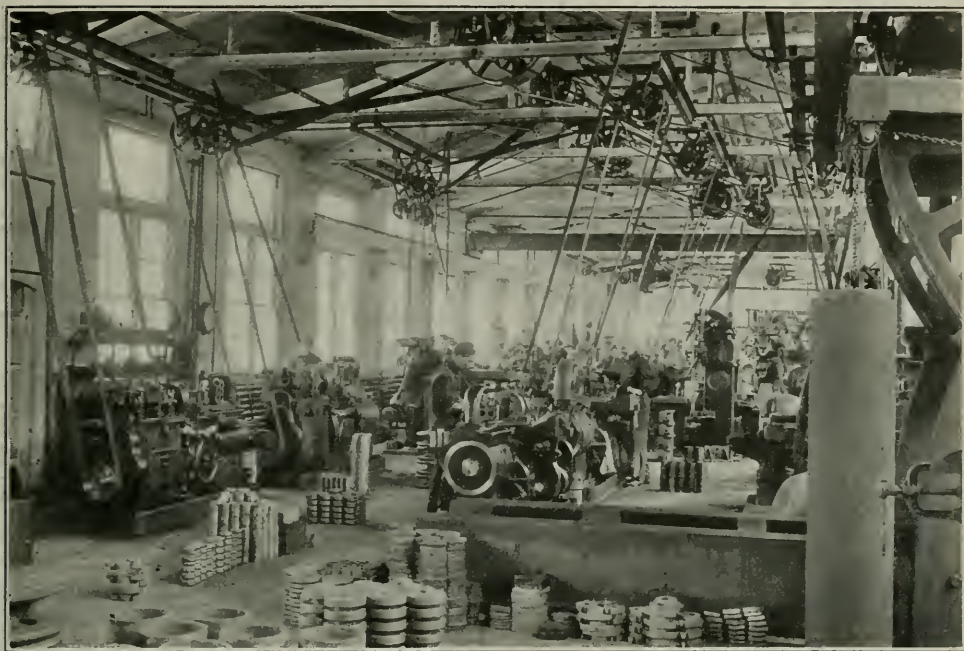


FIG. 8. SEMI-AUTOMATIC MACHINE TOOL DEPARTMENT.

METALLIC POWDERS INCREASING THE POWER OF EXPLOSIVES

A U. S. patent—No. 1,054,777—has recently been granted to Roberto Imperiati, of Brescin, Italy, for increasing the power of an explosive by the addition in a powdered form of such metal as aluminum or silicon, their oxydation during the explosion causing an enormous increase of heat. When tungsten is alloyed with aluminum, the thermal energy of oxidation is increased and the aluminum is rendered more resistant to the action of oxidizing salts. Tungsten may be alloyed with both aluminum and silicon and a still more advantageous result obtained, or the tungsten silicide can be used. These mixtures or alloys reduced to powder before mixing increase the power of any explosive to which they are added, due to their great heat of oxidation. They can be added to explosive mixtures or to nitrated explosives, or can be used alone with a suitable oxidizing agent, such as ammonium nitrate. Such an explosive mixture can be made by drying and grinding the nitrate of ammonia and mixing in the alloy of aluminum, silicon and tungsten until the powder is substantially homogeneous. It is then dried and packed in cartridges. Combinations contain-

ing 65 to 85 parts, by weight, of ammonium nitrate and 35 to 15 parts of the metal mixture, may be used.



FIG. 9. WASH ROOM AND LOCKERS.

PRESSURES IN HOT RIVETING

When the yoke type of riveter is employed to upset and head a hot rivet at a single squeeze the pressure exerted is accurately indicated by the springing apart of the jaws. This has been taken advantage of for measuring and recording the various pressures required for rivets of different sizes, and at different temperatures, and is the subject of an interesting paper by E. D. Hays and W. L. Edwards in the March issue of the *Technic* of Rose Polytechnic Institute.

The deflections of the jaws of the riveting machine were magnified eight times by a pantagraph with a pencil tracing a record upon the drum of a steam engine indicator. The pantagraph was calibrated to determine the tensile displacement corresponding to a given force in the dies, and the result was plotted on cross-section paper, with the actual pressures as abscissæ and the tensile displacements as ordinates, the result being a line with a very slight upward curve.

A 26-in. portable bridge-riveting machine with toggle-driven dies was suspended with the axis of the dies vertical and in such a position that the heads of the Rhiele testing machine were between the die holders and transmitted their stress to them through conical bearings calculated to insure alignment.

After calibration the riveting machine was removed from the testing machine and suspended in a similar position during the remainder of the experiment. Another series of tests was made to determine the difference between the actual and theoretical pressures at different points of the stroke, corresponding curves were plotted from the results, and an efficiency curve was laid out showing that the efficiency increased throughout the plunger stroke until the last, when the theoretical pressure becomes infinite and the efficiency becomes zero. The maximum efficiency obtained was 62 per cent., which it was thought may have been partly due to the newness of the machine.

The rivets were driven through several thicknesses of steel plates clamped together and drilled 1-16 in. larger than the diameter of the cold rivet. They were heated in a portable forge with a hand blower to temperatures varying from 1,100 to 2,700 deg. Fahr., as determined by a pyrometer embedded in the fire close to the rivet, the latter being kept there long



FIG. 10. SPECIAL JIG ON BORING MILL.

enough to acquire the temperature of the fire. It was believed that the drop in temperature between the forge and the riveting machine did not exceed 200 deg.

All of the rivets were of standard lengths and had enough material to furnish a little excess steel in the head. The grips of the rivets varied from $\frac{5}{8}$ to $1\frac{1}{8}$ in. The shortest ones filled the holes completely, which was not the case with some of the longest ones. No loose rivets were found, and when some of the rivets were sawed through it was noticed that the very hot rivets had not filled the holes any better than some of the coldest ones. It was noted that the pressure did not increase in any large ratio as the plate thickness increased.

The lowest pressures, which caused many to completely fill the holes where the rivets gripped two plates whose combined thickness was about equal to the diameter of the rivets, were about as follows: For 1-in. rivets, 82,000 lb.;

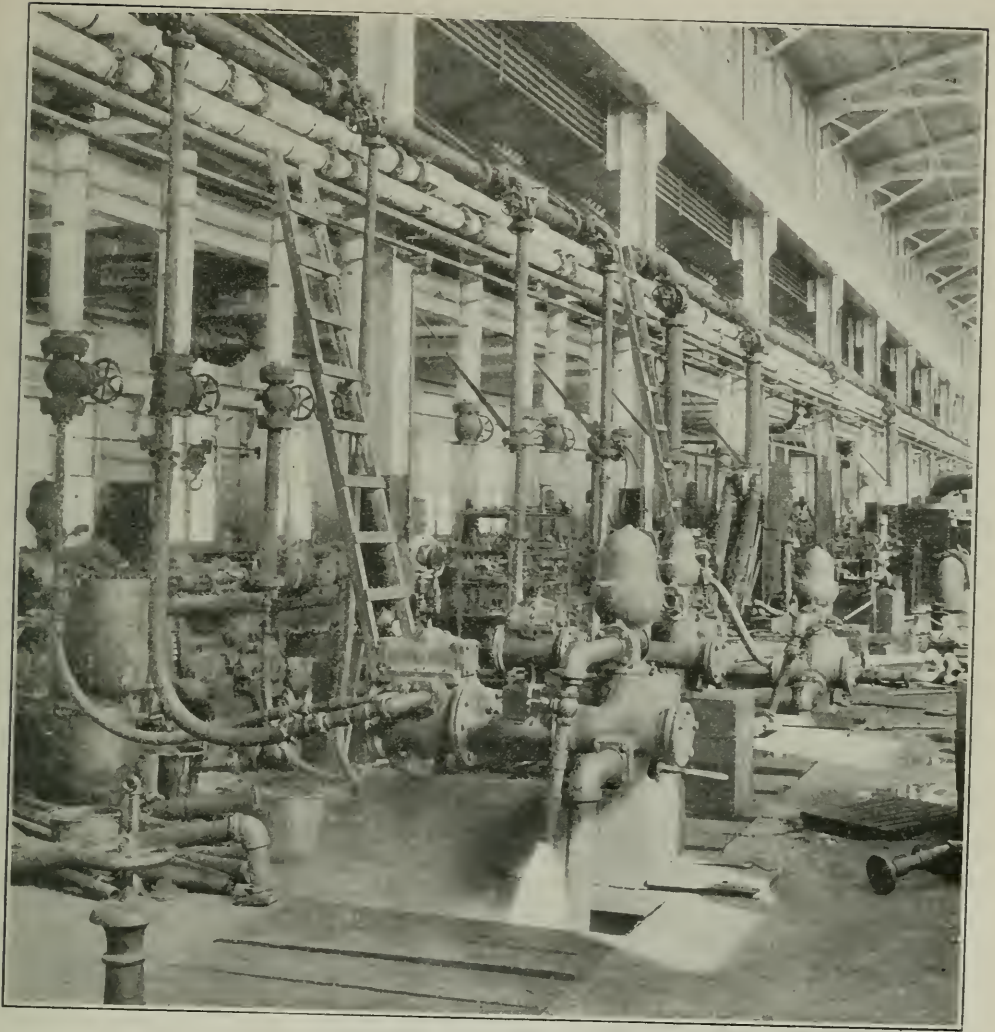


FIG. 11. STEAM PUMP TESTING DEPARTMENT.

$\frac{7}{8}$ -in. rivets, 70,000 lb.; $\frac{3}{4}$ -in. rivets, 60,000 lb.;
 $\frac{5}{8}$ -in. rivets, 35,000 lb.

Of the 53 rivets driven, fourteen $\frac{5}{8}$ -in. rivets were driven at an average temperature of 1,914 deg. and an average pressure of 65,357 lb., and in an average time of 11 seconds each. Seventeen $\frac{3}{4}$ -in. rivets were driven at an average temperature of 1,935 deg., 58,823 lb. pressure and 8 seconds time; fifteen $\frac{3}{4}$ -in. rivets at 2,120 deg. temperature, 74,600 lb. pressure, and 11.7 seconds time; three 1-in. rivets, 2,400 deg. temperature, 53,000 lb. pressure and 20 seconds time; four $\frac{5}{8}$ -in. rivets at an average pressure of 53,500 lb.

THE CORNISH MINER

BY P. B. MC DONALD.

The race that has done the most in the actual digging of ore in the mines of the United States is the Cornish. The Cornishman has not done much in the financing department, nor has he any letters after his name, but he has made a reputation for getting out the ore. In nearly all of the mining districts, Cornish miners and Cornish foremen are prominent. This is particularly true of the iron and copper ranges of the Lake Superior district, where he is an important factor. He



FIG. 12. CENTRIFUGAL PUMP TESTING SHOWING DYNAMOMETER.

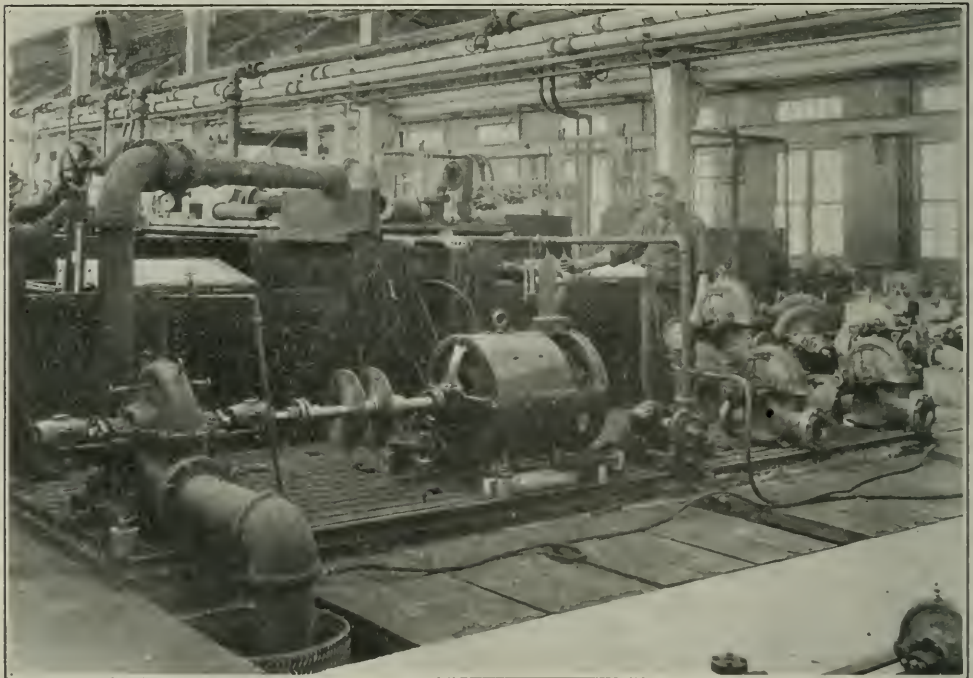


FIG. 13. REAR VIEW OF CENTRIFUGAL PUMP DYNAMOMETER TEST.



FIG. 15. SHOWING QUANTITY PRODUCTION.

is often to be found in the "Captain's" office, but in older mining communities will be found in nearly every capacity underground. You may catch him sitting and "smokin' 'is pipe," but at quitting time he will "'ave hout 'is hore." To a Cornishman a mine is a "hore-body" that must be "got hout" of the ground. To him the mine means a "West Hend" and

a "Heast Hend," and the "Blue Stope," and the "'ard Hore Drift."

It is natural for the Cornishman to be a good miner, for very likely his father and grandfather worked in the mines of Cornwall. Sometimes the Cornish mining-captain and the mining-engineer don't get along well. This is because each arrives at his conclusions by an entirely different course. The engineer reasons things out, the Cornishman just "sees 'em."

Of course, with all his good points, the Cornishman has his faults. His aversion to shoveling is well known. At a small exploration near Iron River, two men were employed underground on each shift, and the day shift (composed of Swedes) threw all the shoveling possible on the night shift, while the night shift (composed of Cornishmen) did the same or a little better to the day shift. One night the Swede foreman, who was on surface, noticed that no dirt was coming up as there should have been; he jumped on the bucket and went down. The Cornish miner and help-

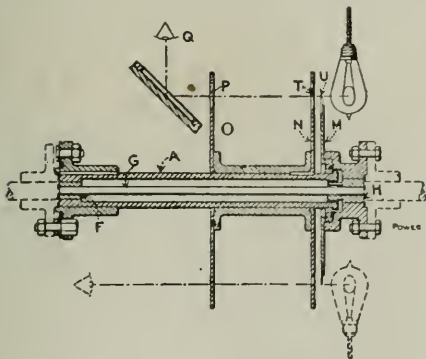


FIG. 14. SKETCH OF DYNAMOMETER.



FIG. 16. IN THE FOUNDRY.

er were drilling merrily away, regardless of the pile of dirt that should have been shoveled into the bucket.

"Who in h—l gave you instructions to drill?" roared the foreman. The Cornishman, a first-rate miner, looked around, "Hi'm d—d sure hit wasn't Presdunt Roozevelt!" he answered.

In the community where the Cornishman lives, he takes great interest in local politics and likes to represent his section as alderman or supervisor. Many stories are told of elections in the old days, held perhaps in the school-house, and of how, when the captain stood up, everybody else stood up. Another method much in vogue, was to vote by lining up on different sides of the room (where the captain could get a good look at each man); in outlying communities, this practice is still in use.

A Cornish miner who has worked a long time in a successful mine, will finally retire on a rocky little farm overlooking the scene of his former labors, and will live there happily in preference to moving into town. He likes to see daily the mine where he worked; if it is exhausted and closed down, he will tell you where he thinks the "hore" is, and will exhibit

confident belief that the place will boom again some day. If the railroad has never been built there, he will predict its coming and will indicate the site where he thinks the station should be located, ending by declaring that he only hopes to live to see it.

Throughout the Lake Superior region he can be seen driving into town on a sunny day, or going in for a glass of "'arf-and-'arf," or sending "five poun'" to a nephew in the old country to help him come across. Whether he was a foreman or a miner, he enjoys being called "captain" and is always willing to stop and discuss "minin'."—*Eng. and Min. Journal*.

E. L. Hand, of Chicago, has just completed the invention of a cement gun which works like the older cement gun by compressed air, but the nozzle and mechanism is in no way similar to the old cement gun. Mr. Hand has worked the old gun, and observed the imperfections of that machine, particularly the vibratory motion, and the tendency of the materials to separate at the point of impact. He claims to have overcome the vibration objection entirely and to have reduced the waste of material to a very great extent.

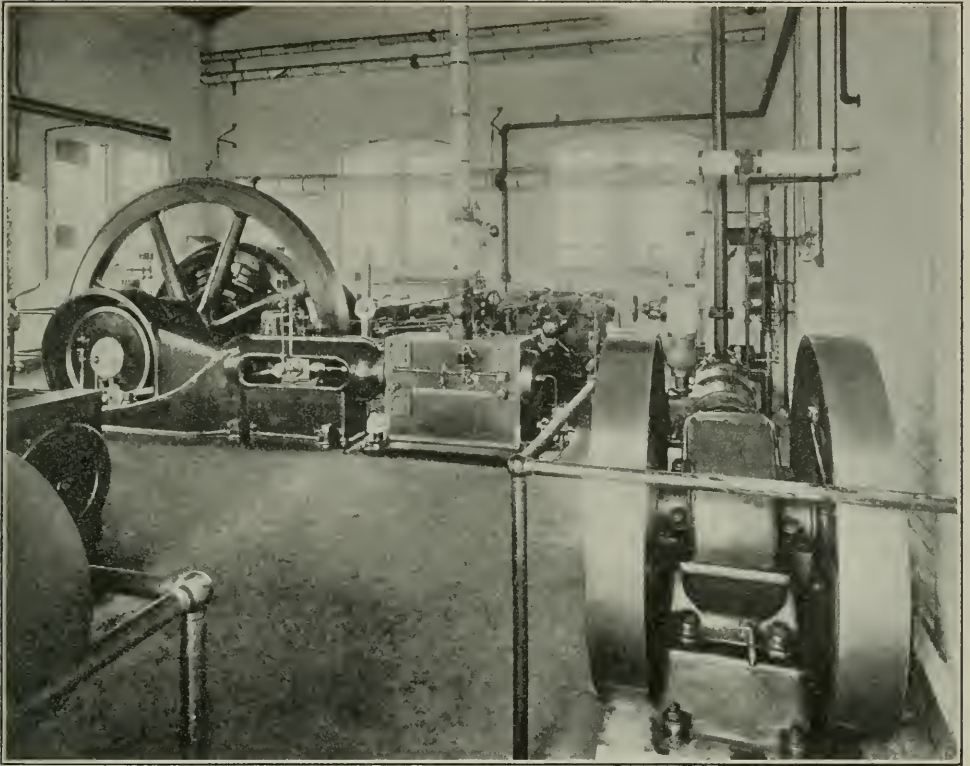


FIG. 17. IN THE POWER HOUSE.

BUREAU OF MINES PERMISSIBLE EXPLOSIVES

An explosive is called a permissible explosive when it is similar in all respects to the sample that passed certain tests by the United States Bureau of Mines, and when it is used in accordance with the conditions prescribed by this bureau.

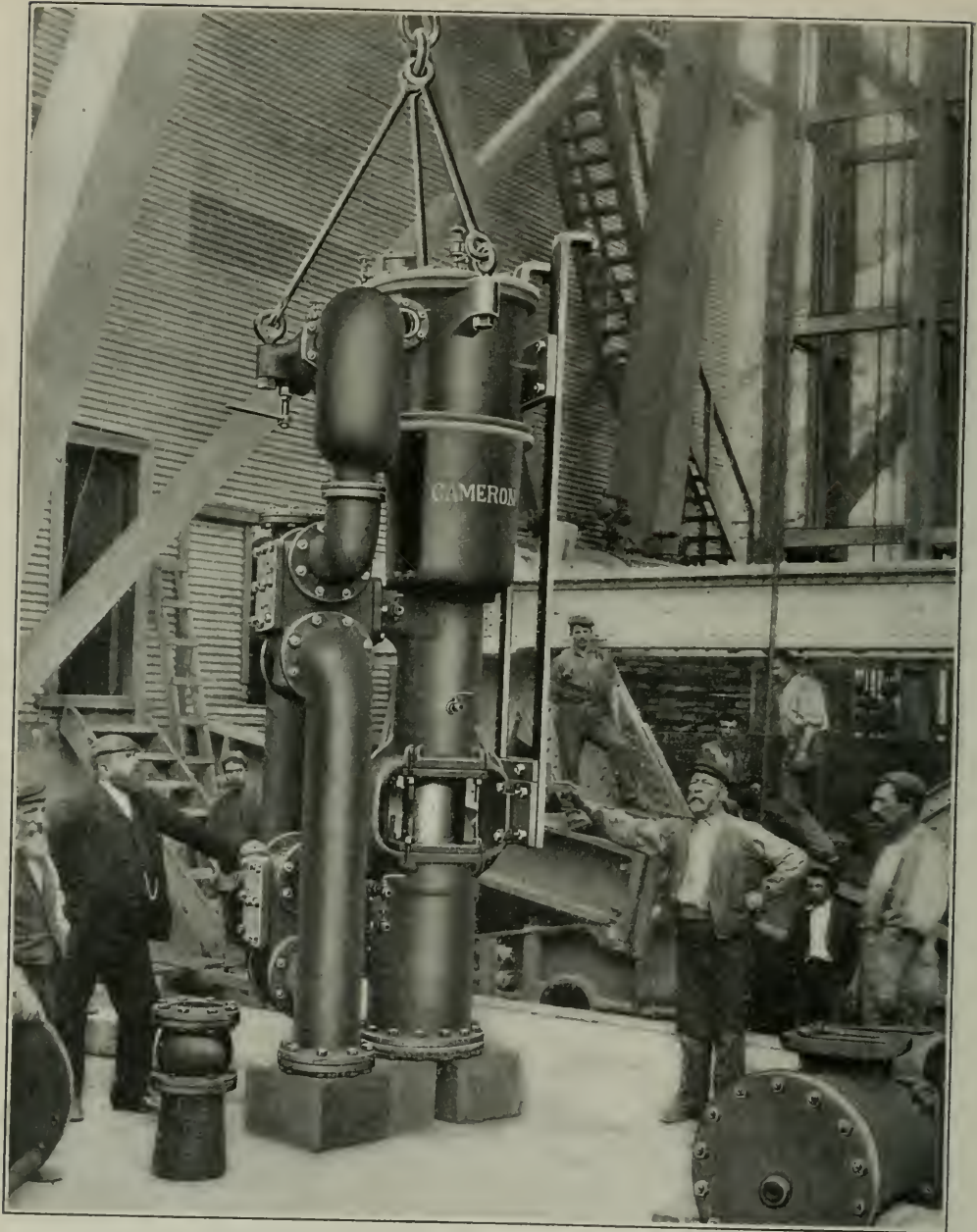
But even the explosives that have passed those tests and are named in this list as per-

missible explosives are to be considered as permissible explosives only when used under the following conditions:

1. That the explosive is in all respects similar to the sample submitted by the manufacturer for test.
2. That detonators—preferably electric detonators—are used of not less efficiency than those prescribed, namely, those consisting by weight of 90 parts of mercury fulminate and 10



FIG. 18. THE LAKE AND WATER-COOLERS.



VERTICAL PLUNGER SINKING PUMP, AUKLAND, NEW ZEALAND.

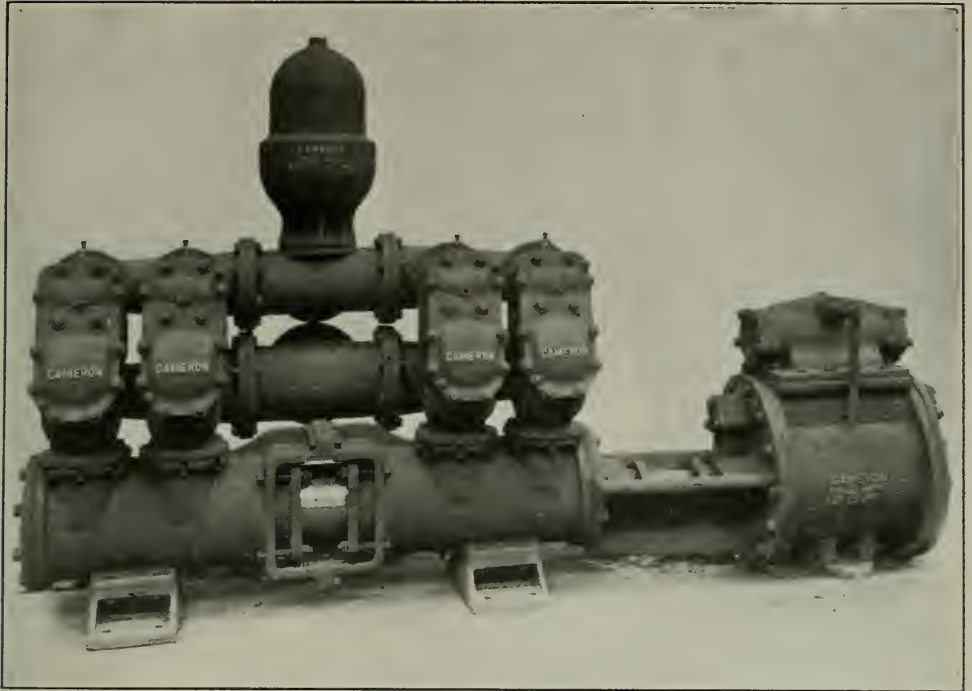
parts of potassium chlorate (or their equivalents).

3. That the explosive, if frozen, shall be thoroughly thawed in a safe and suitable manner before use.

4. That the quantity used for a shot does

not exceed $1\frac{1}{2}$ pounds (680 grams), and that it is properly tamped with clay or other non-combustible stemming.

It must not be supposed that an explosive that has once passed the required tests and has been published in lists of permissible explo-



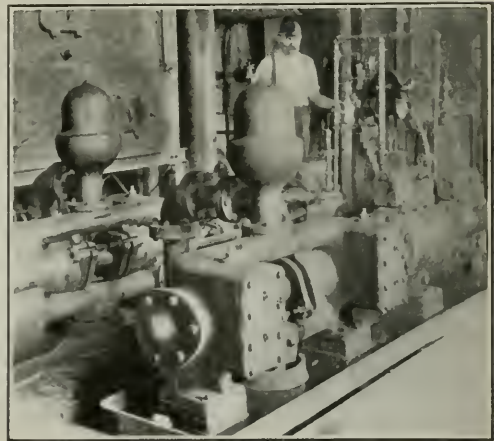
HORIZONTAL POT VALVE PLUNGER PUMP, CEMENT LINED.

sives is always thereafter to be considered a permissible explosive, regardless of its condition or the way in which it is used. Thus, for example, an explosive named in the permissible list, if kept in a moist place until it undergoes a change in character, is no longer

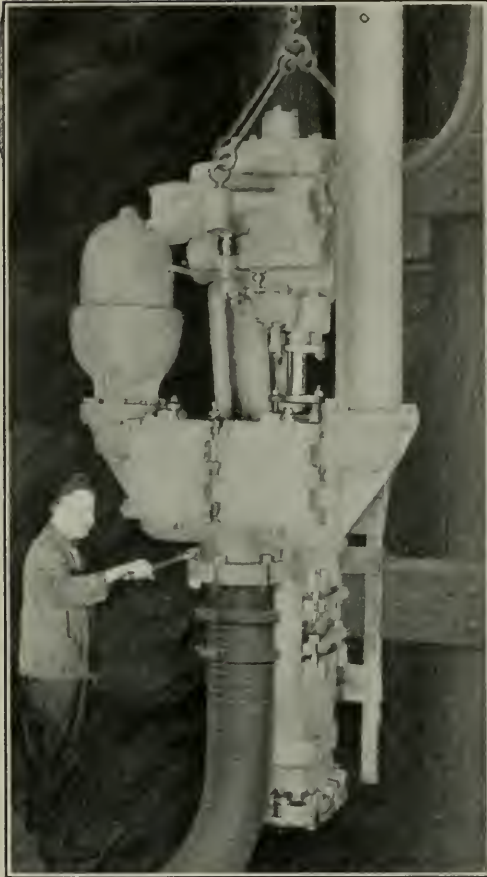
to be considered a permissible explosive. If used in a frozen or partly frozen condition, it is not when so used a permissible explosive. If used in excess of the quantity specified ($1\frac{1}{2}$ pounds), it is not, when so used, a permissible explosive. And when the other conditions have been met, it is not a permissible explosive



VERTICAL DOUBLE VOLUTE PUMP, PANAMA CANAL.



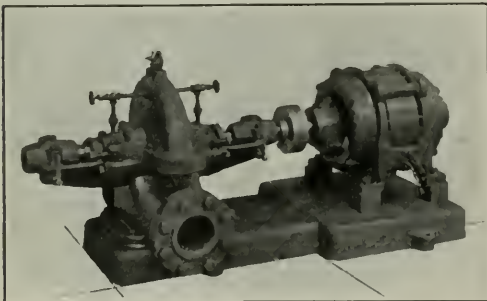
COMPOUND PLUNGER BOILER FEED PUMPS.



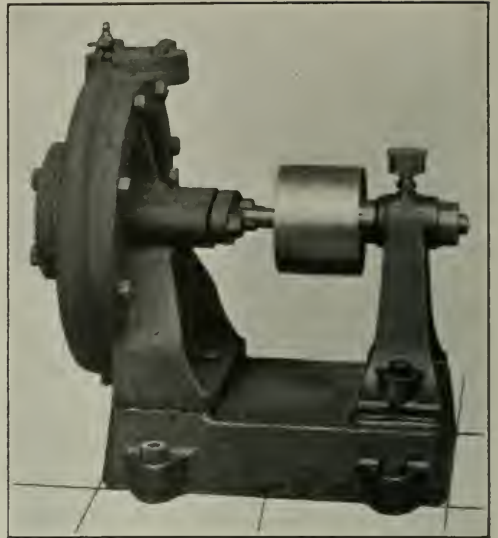
VERTICAL PLUNGER SINKING PUMP.

if fired with a detonator of less efficiency than that prescribed.

Moreover, even when all the prescribed conditions have been met, no permissible explosive should necessarily be considered as *permanently* being a permissible explosive, but any permis-



MOTOR DRIVEN VOLUTE PUMP.



SINGLE SUCTION VOLUTE PUMP.

sible explosive when used under the prescribed conditions may properly continue to be considered a permissible explosive until notice of its withdrawal or removable from the list has been officially published, or until its name is omitted from a later list published by the Bureau of Mines.

Liquid air, and more especially liquid oxygen, are being experimented on in Germany as mine explosives, according to *Echo des Mines*. The latter, mixed with aluminum powder, and detonated, forms an explosive about $2\frac{1}{2}$ times as powerful as black powder, from which there can be no deleterious fumes, as the only products of an explosion are oxygen and alumina.

For four years the town of Ocos, in Guatemala, enjoyed the benefits of electric lighting, but now it has reverted to oil lamps, as its power-house has gone to sea! It appears that a vessel of the Cosmos Line was driven into the shallows near the town by a large wave, and remained imprisoned in the lagoon, but without being damaged. Some enterprising person thereupon used the dynamos on board for lighting the whole town by electricity. The scheme was a great success, until a still more enterprising man came along who undertook to extricate the ship from its awkward position, and succeeded. The leads were cut, the vessel went back to sea, and the inhabitants of Ocos went back to oil lights.

AIR LIFT PUMPING AT HOUSTON

A recent report of J. B. Williams, superintendent of the water department at Houston, Texas, gives interesting information concerning the water supply. The city is using about forty wells and all of them are now operated by air lifts.

The first wells were sunk in 1888, and by 1899, 31 wells had been sunk, all used without the air lift. In that year, 13 of the wells were piped with air, and the others were modified in the same way in succeeding years, practically all of those drilled since 1899 having been provided at the same time with air lifts.

In applying the air lift, the central water pipe was lowered to a depth of from 123 to 128 feet, except in one case where it reached 183 feet; while the air pipe was lowered to 120 feet in all but two cases where the depth was 2 feet greater. The central water pipe varied in diameter from $3\frac{3}{4}$ inches to 8 inches, depending upon the size of the well. The air pipe varied from 1 inch to 2 inches, being $1\frac{1}{4}$ inches in most cases.

In about half of the wells sunk in 1899 and all of those since that time, no central water pipe was used, and the air pipe was increased to a diameter of $1\frac{1}{4}$ to 5 inches, the majority being 3, $3\frac{1}{2}$ or 4 inches.

Before air was applied, these wells varied in discharge from 28,800 gallons per day to 724,800 gallons; while after the addition of air the flow of the former of these was increased to 159,840 gallons, and the flow of the latter to 1,123,200 gallons. Air was applied to the former in November, 1900, and about a year ago the well had ceased to flow altogether either with or without the use of the air lift. The latter well was finished in January, 1905, when it delivered 724,800 gallons. The air lift was added in January, 1907, which increased the flow to 1,123,200; but five years later, the flow without the air lift was found to be only 90,000 gallons, and with the air lift 985,000 gallons. The average of all of the wells supplied with air lifts was as follows: Natural flow before air was applied, 169,770 gallons; flow with air lift when first applied, 507,879 gallons; flow in January, 1912, without air, 57,257 gallons; flow in January, 1912, with air, 316,118 gallons.

It is seen by the above figures that when the wells were new, the use of the air lift in-

creased the flow on the average nearly three times. At the time of the report the wells then in use averaged twelve years old, and the flow without air averaged a little over one-third as great as when the wells were first put into service, and about 54 per cent. as much water could be obtained by the air lift as was obtained when the air was first applied to the wells. Also it was found that the flow obtained by the air lift at the time of the report was about five and a half times as great as the flow without air at that time, 17 of the wells showing no flow whatever without the use of air.

A new method of removing hard scale from boilers is described in "Engineering." The apparatus (known as the "Pyro" boiler cleaning system) used consists of an oxy-acetylene blowpipe with two or three jets, a portable acetylene generator, a steel cylinder of compressed oxygen, and the necessary length of flexible tubing. When it is desired to remove any scale, the blowpipe flame is played upon it for a few minutes (depending upon the thickness of the scale) until the scale cracks and falls off due to rapid expansion under the high temperature. If the scale is slightly damp, the operation is assisted. Care should be taken to keep the flame from playing on the bare plate for any length of time.

Giving indication of appreciation of the thoughtlessness of motorists in general, one prominent manufacturer has taken to equipping his cars with an oil level indicator which short circuits the ignition current when the supply of lubricant drops below normal. It is nothing more complicated than a tube enclosing a float buoyed up by the oil. The float carries a contact which touches another contact when the float drops, thus short-circuiting the magneto and giving unmistakable indications of the scarcity of oil.

Experiments made to bring aluminum to a liquid condition so it may be spread when cold over any dry surface have, according to the German press, been crowned with success. The composition is applied like paint with a brush and looks, when spread, like a dull silver coating.

A PROBLEM IN MINING, WITH SOME DATA ON TUNNEL MINING

BY W. L. SAUNDERS.

[The following is in discussion of a paper with the above title by F. M. Simonds and E. Z. Burns, presented at the New York Meeting, Feb., 1913, of the American Institute of Mining Engineers].

Mr. Burns in his native Colorado modesty has said that he apologizes for things left out of this paper. I am much impressed by what he has put into the paper, as, of all the papers that I have read on the subject, describing, as it does, a specific piece of work that has been accomplished, I do not recall one that gives so much information in such a practical way. Mr. Burns has said that it is very hard to get men to put things down while the work is being driven. My experience is that it is very much harder to get the men in charge of work of this kind to bring them in in the form of a report before a body of engineers after the work is done. We have a great many cases where records are kept in much detail, but they are usually kept under cover, with the mistaken idea that the information gained is private information for the benefit of those who have done the work. Messrs. Simonds and Burns have opened up this case so that we can get the benefit of that experience which they have had, and so that we can learn something for the future.

The description contained in this paper, as I have said, is a very practical one. You will notice in going through it that the authors have given in detail a record of their work from the beginning to the end, and they even go so far as to publish an exact copy of the Rawley Mining Co.'s daily report. That daily report is something which those of us who are engaged in similar work might copy to great advantage, and having it before us we can check up our men while doing work and exact from them equal conditions, if it is possible to do so.

The dimensions of this tunnel are 7 ft. high by 8 ft. wide, with a length of a little over 6,000 ft., so you see we have here a typical mining tunnel, a little over one mile long, and with the usual dimensions of 7 by 8 ft. The best monthly progress, firing from 8- to 12-ft. rounds, was 414 ft., and the best monthly progress for the shallow rounds, from 4.5 to 5.5 ft., amounted to 555 ft. I want to call par-

ticular attention to that statement, and those of you who have read the paper will see that when they changed from a double shift to a triple shift, putting in shallow holes, they got better progress. The shallow hole idea is the European idea, it is the Alpine tunnel idea, it is the idea by which engineers have carried through those great enterprises of piercing the Alps, in the case of the Simplon tunnel and the Arlberg and the Loetschberg tunnels. These recent tunnels which have been put through the Alps have all been driven on the shallow hole plan; in other words, a hole is put in about a meter or a little more than a meter in depth, and of rather large diameter, as compared with the American system, which is, a hole as large as you can reasonably get it, and that means, by the time it is in to the bottom, say 10, 12, or 14 ft., it is just a little larger than the diameter of the steel, the result being that you are putting the explosive at the bottom in a section of hole of small diameter, which is the very reverse of what is wanted in order to produce the most effective results. It is much better—and this is a point that I have emphasized before the Institute in papers in the past years—to put in a large number of shallow holes of large diameter and use a great deal of powder than to put in a small number of deep holes and try to save powder and try to be very particular about the exact direction that the hole must take. The European system simply peppers the head with holes, and better results are obtained by that method.

The total cost per foot of advance in the completed tunnel was \$19.87. That is a very fair figure, and less than the estimate of cost made before this tunnel was driven. The average total cost per cubic yard excavated was \$7.64. That may seem high to some of us, but if you go over the figures of labor cost in this paper you will see that the wages are higher. The people employed on this work evidently were compelled to pay a maximum rate of wages for this class of work, and, taking that into consideration, the figures are not high. The average number of feet of hole per drill per drill-hour was 12.2. The average inches per drill per minute was 2.5. The approximate yardage per foot of advance, allowing for 25 per cent. of overbreakage and swelling, was 2.6 yards, or a cost of \$7.64 per cubic yard. In all of this we must take into consideration the

difficult rock which was encountered and the water troubles which they had; yet, comparing the progress of this tunnel with that of any of the recent tunnels of which we have records, the progress appears to be very favorable. The most recent of these records was made at the Arizona Copper Co.'s mines at Morenci, Ariz., the tunnel being 8 by 9 ft., where 780 ft. advance was made in 29 days, employing two C-110 drills mounted upon a cross-bar. We also have the record of the Laramie tunnel, in Colorado, which is similar to this one except that it has a ragged section. It is nothing but a hole, without any specified dimensions of outline, but it serves its purpose very well as a drainage tunnel. Being ragged, it enabled progress to be made in excess of that given in this paper.

Now, the description of the process of driving tells us that this tunnel was driven by the system of mounting the drills on a horizontal cross-bar across the tunnel. Here we have a thoroughly modern system; the same, by the way, as was used at the Laramie tunnel. In the American system of tunnel-driving vertical columns with arms on them are usually employed. The European system of tunnel-driving is one in which horizontal bars mounted on carriages are employed. The system described in this paper is neither one nor the other, but the drillers used a horizontal bar without any carriage; in other words, they adopted the Alpine system of tunnel-driving, but did away with the carriage. Now, they were able to do away with the carriage because they used hammer drills instead of piston drills in the headings. The piston drill is a machine which reciprocates and which creates a great deal of shock on its mounting, necessitating a very heavy bar or column. The machine itself is heavy, and necessitates the use of either the carriage system or the vertical column with arms.

It appears that those who drove this tunnel used the hammer drill, which is lighter in weight and does not give the jarring and reciprocation, hence they were able to use a light bar, which a few men in the heading can handle to advantage. This light bar is carried on top of the muck pile after the blast and jacked in place close to the roof; the drills are put on and put in operation; the men work the drills standing on top of the muck, the

muckers being at work at the same time in digging away the muck underneath them. By the time the muck is largely removed the drillers are about ready to let the bar down, and just about that time the muck has been taken away, so that if necessary the bar can be placed in a lower position in order to put in the lower round of holes, if these cannot be drilled from a single setting of the cross-bar. By such a system as this they were able to make a progress, I believe, of 26 ft. per day; in other words, a little more than 1 ft. an hour during all of the 24 hours in the day. That, of course, is not the record. The Alpine system has made about 30 ft. per day, and in the Laramie tunnel they made something like 24 ft. a day. Comparing progress of this character, however, we must always take the character of the rock into consideration; also the length of the tunnel. The Alpine tunnels are longer tunnels, and, by adopting a certain system and carrying it out for a long period of time, it was possible to get the efficiency of the workers very high.

The engineers in this tunnel decided that better results could be obtained by drilling shallow holes and operating three shifts per day. This plan was put into effect in December, 1911, and, as I understand from reading the paper, it proved to be very efficient. The results, as given in the table printed in the paper, show that the average number of feet of hole per drill per drilling hour was 12.2. This is good, but not remarkable, as it involves only approximately 2.5 in. per min. Of course, the rock conditions govern this. On page 393 reference is made to the results obtained in the entire equipment of the tunnel.

This subject is one which is very active at the present time, because American engineers are adopting a system of tunnel-driving which is to a certain extent a cross between the European and the old American system, but which has, I think, a great many points of advantage over both of them.

It is stated in *Consular Reports* that in all countries where shipbuilding is carried on the shipyards have been besieged with so many orders that at this time it is impossible to place an order for a new steamer which can be completed before 1915.

THE ACTUAL VALUE OF INTERCOOLING IN AIR COMPRESSION

BY R. S. HOWARD.

When guarantees of economic performance of any piece of power machinery are made, the guaranteed results are always stated to be reached under certain definite and specified conditions. For instance, steam engine economy is stated with a certain steam pressure at the throttle, a certain vacuum at the exhaust, a certain load and a certain speed.

For air compressing machinery the air end is guaranteed to deliver a certain quantity of air against a certain discharge pressure at a certain speed, and measured at the temperature and pressure of the intake, the barometer reading being known. Also this is to be done with the horse power exerted not exceeding a certain figure, when *perfect* intercooling is attained.

This matter of intercooling the air between the stages of compression is of extreme importance, because the horse power is materially influenced by the degree of intercooling. The opportunity of intercooling is the one and only reason for multi-stage compression of air, and the benefits are twofold.

First, intercooling reduces the temperature of the partially compressed air before it enters the next cylinder, and thus reduces the final temperature of discharge of this next stage. The compression of air from atmospheric to 100 lb. gage pressure, starting from 60 deg. F., results in a final temperature not far from 480 to 500 deg. When air is compressed to such a temperature as this there is danger of the carbonizing of the lubricating oil, and in large quantities, where the heat is not carried away, explosions of mixtures of air and oil are altogether too frequent.

If this work is done in two stages, with proper intercooling before entering the high pressure cylinder, the temperatures can be kept down to between 250 and 275 deg. The final temperature depends somewhat on the speed of the machine, as at high speeds the water jackets around the cylinder walls are not so effective as at slower speeds.

The other reason for stage compression and intercooling is to reduce the horse power required to compress the air. For instance, to compress 100 cu. ft. of air to 100 lb. gage pressure in one minute by single stage compression requires somewhat over 18 I. H. P. in the

air cylinder, while if this is done in two stages of equal work, the horse power will be about 15.5. This reduction in temperature is due solely to the cooling of the air, and the attendant reduction of its volume before it enters the second stage cylinder.

In order to make the saving above mentioned, it is necessary that the air shall be intercooled back to the temperature at which it first entered the low pressure cylinder. This is described as "perfect intercooling." The other extreme is no intercooling at all, which amounts to plain, single stage compression, irrespective of whether it was done in one cylinder or two. Between these two extremes lies the middle ground of partial intercooling, which is the condition most often met in practice. The degree of intercooling depends upon the area of the intercooler surface and the amount and temperature of the cooling water. The relative area of the cooling surface depends upon the quality of the machine; the finer the grade of machine purchased, presumably the greater the cooling area per cubic foot of air compressed. Modern practice has greatly increased the cooling surface provided. The quantity and temperature of the cooling water are largely local matters, and are sometimes beyond control.

This last puts the air compressor performance somewhat at the mercy of local conditions, especially the weather. For suppose the intake air is at, say 20 deg. F. and the cooling water is at 35 deg.; obviously no amount of cooling water will produce "perfect cooling," no matter how much cooling surface is provided in the compressor. In fact, with present day coolers of usual design, the temperature of the air leaving the intercooler can scarcely be colder than 20 deg. *above* the temperature of the incoming water. Thus, with 60 deg. atmosphere, 40 deg. cooling water, and plenty of it, with adequate surface, the air would leave a properly designed intercooler at 60 deg. and there would be a condition of "perfect" intercooling.

Because such a thing is commercially possible, and is a standard base upon which to figure, air compressor builders always specify "perfect intercooling" when guaranteeing horse power requirements. The fact that local conditions so often limit the possibility of intercooling, renders it necessary in almost all cases of economy tests of air compressors to make

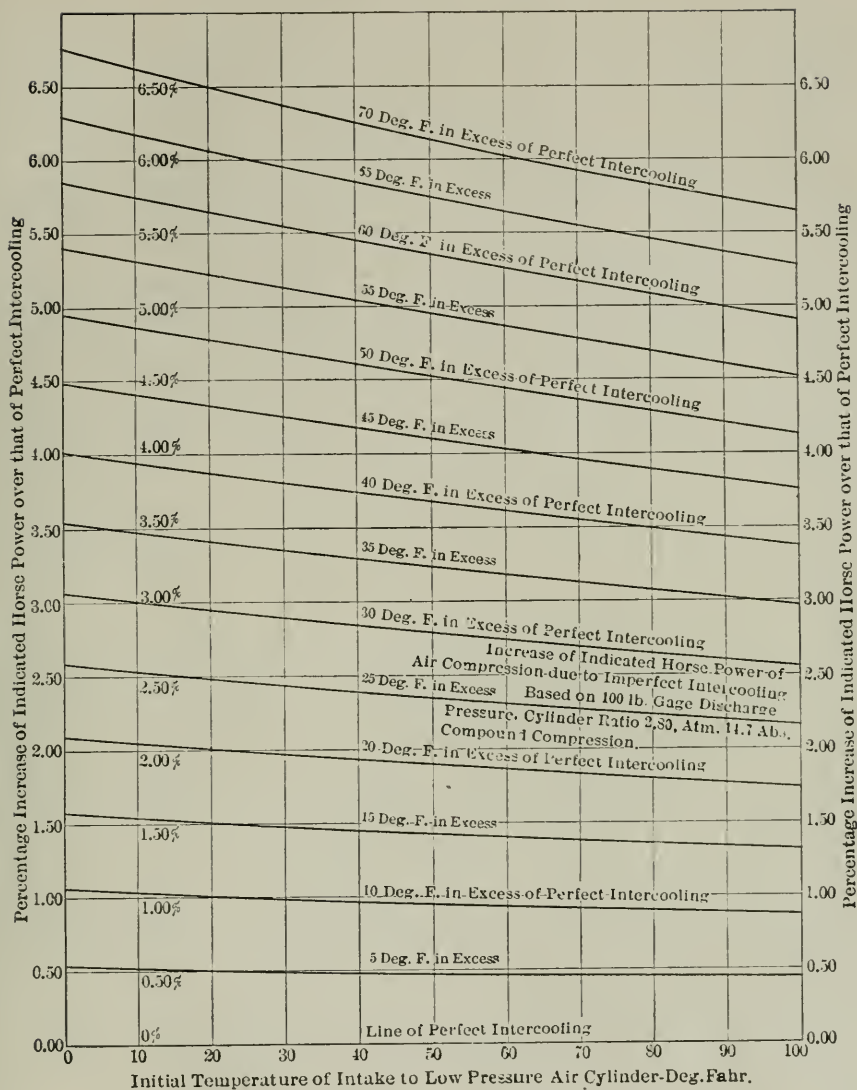


FIG. 1—INCREASE OF INDICATED HORSEPOWER OF AIR COMPRESSION WITH PARTIAL INTERCOOLING

a correction of the test figures for the actual cooling attained, in order to compare the results with the guaranteed figures. This process is not an easy one, and where there are several tests to figure, it becomes laborious and tedious, as well as a great consumer of valuable time.

This state of affairs is due to the apparently curious fact that, while with perfect intercooling the total horse power of an air

compressor is not affected by the temperature of the air it takes in, with imperfect intercooling the horse power is affected by the temperature of the intake air. Thus, with perfect intercooling, the horse power of the air cylinders will be the same, no matter whether the air received is at 20 deg. or 60 deg. or 120 deg. or any other temperature, always assuming that the air entering the second stage is cooled back to the same temperature as that

entering the first-stage cylinder. However, if the intercooling is, say, 35 deg. short of perfect, so that if the fresh air is at 20 deg. F. and that entering the second stage is at 55 deg. F., the horsepower will be increased 3.42 per cent.; whereas, if the initial temperature is 80 deg. F. and the intercooling is only to 115 deg. F., the increase in horse power over perfect cooling will be only 3.07 per cent. The reason for this is that the increase in horse power is a function of the absolute temperature ratios, and the higher the temperatures are, a given difference of temperature makes a smaller ratio; thus, 20 deg. F. is 481 deg. absolute, and 55 deg. F. is 516 deg. absolute, so that their ratio is $516 \div 481 = 1.072$; while 80 deg. F. = 541 absolute, 115 = 576 deg. abs., their ratio being $576 \div 541 = 1.064$. The calculation is not nearly so easy as this, as it involves fractional exponents, and for accuracy requires the manipulation of at least five significant figures because of the small ratios involved.

Because the writer has had a great deal of this calculating to do, and because it is not only laborious and time-absorbing, but also difficult to perform accurately and consistently with a slide rule, by reason of the small ratios and fractional powers involved, the accompanying diagrams have been plotted. These give the percentage increase of indicated horse power with various degrees of cooling, from perfect up to a discrepancy of 70 deg., with intake temperatures from zero to 100 deg. F. at the entrance to the low-pressure cylinder. In diagram given in Fig. 1, horizontal distances represent initial temperatures at the entrance to the low-pressure cylinder, vertical distances represent the percentage increase of horse power over that required with perfect intercooling, and the diagonal lines represent various excesses of temperature over and above the temperature of the intake to the low-pressure cylinder. Thus, suppose the low-pressure intake is at 20 deg. F., and the high-pressure intake is at 55 deg. F.; then the "excess of temperature above perfect intercooling," as shown on the diagonal lines, would be 55 less 20, or 35 deg. F. If we enter the diagram at the line of 20 deg. low-pressure initial temperature and follow it up to where it intersects the diagonal line corresponding to "35 deg. excess," we find the increase of I. H. P. is 3.42 per cent., as previously stated. Also, as in our previous case, if the initial low-

pressure temperature was 80 deg. F., and the temperature of the high-pressure intake was 115 deg. F., the excess of temperature of the high-pressure intake was 115 deg. F., the excess of temperature would again be 35 deg., and following the 80-deg. initial temperature line up to its intersection with the diagonal line of 35-deg. excess temperature, we find the increase of horse power is 3.07 per cent.

The diagonal lines for excess temperature appear to be almost straight. As a matter of fact, the bottom line of no excess temperature is straight, of course, but it will be found by trial with a straight-edge that the lines become more and more curved the greater the excess temperature. The calculations have been carried only to an excess of 70 deg. above perfect cooling, because excesses greater than this would seldom occur with modern designs, and certainly never would be allowed in any economy test.

For the practical use of the diagram in Fig. 1, let us suppose that the I. H. P. of a given compressor was found on test to be 432, and that when the test was made the low-pressure initial temperature was 33 deg. F., and the high-pressure initial temperature 75 deg. F. This gives us an "excess temperature" of 42 deg. with 33 deg. initial, which we will find from the diagram to give an increase of I. H. P. of 3.97 per cent. above that which would be developed if the temperature of the high-pressure intake also had been 33 deg. F., or a condition of perfect intercooling. If these temperature conditions cause an increase of I. H. P. of 3.97 per cent., the horse power which the compressor would have required with perfect intercooling would be found by dividing its actual horse power by 1.0397, or $(432 \times 100) \div 103.97 = 415.5$ I. H. P.

If the guaranteed figure had been "not to exceed 417 I. H. P.," the machine would have met the guarantee when the correction for intercooling was made, but would apparently have failed by 15 H. P. if no corrections were made. This illustrates the importance of such a correction as this and the great necessity of having it accurate, which, as said, is difficult with a slide rule. This and the fact that the results vary with every different intake temperature should make these curves of real practical value to all who have such work to do.

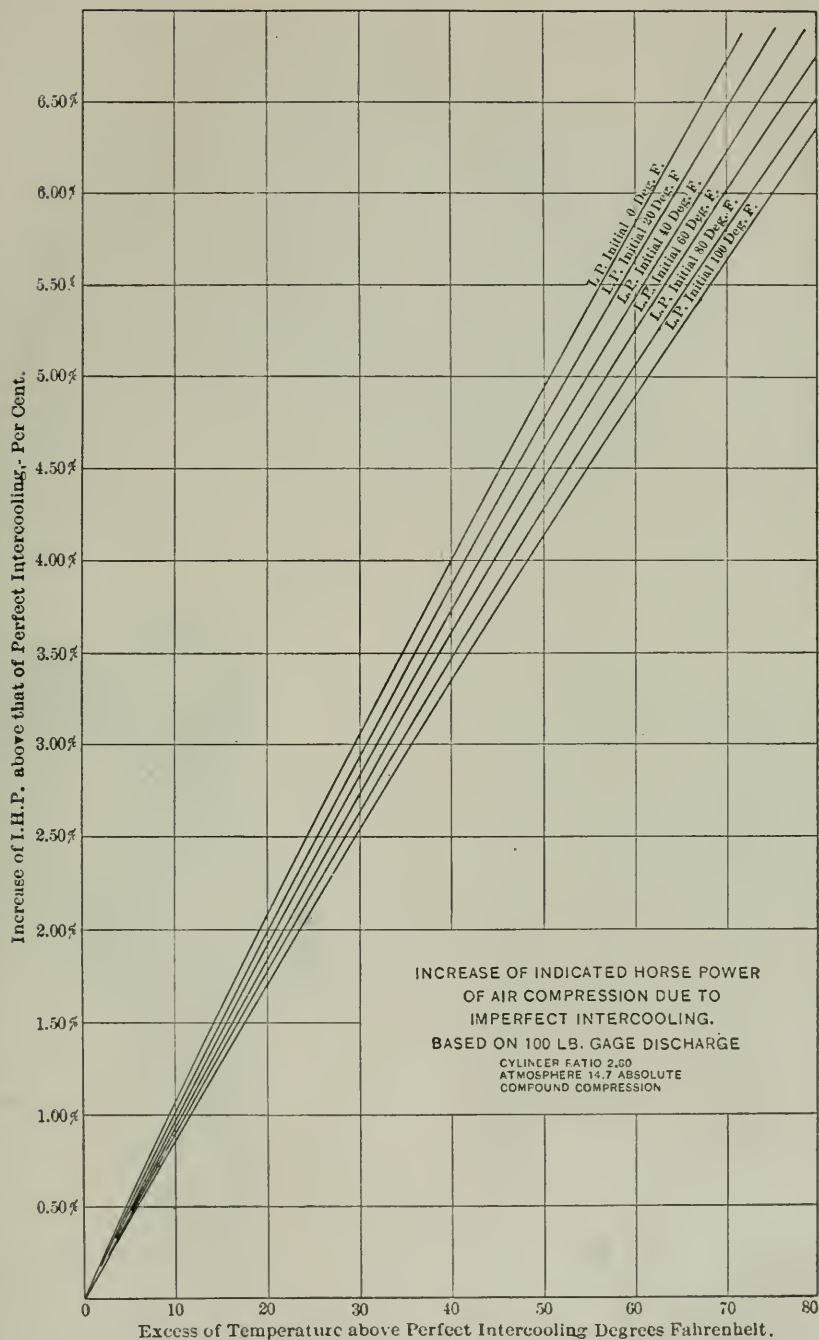


FIG. 2—INCREASE OF INDICATED HORSEPOWER OF AIR COMPRESSION DUE TO IMPERFECT INTERCOOLING

The curves have been plotted on an assumption of compression from atmospheric to 100 lb. gage pressure in two stages, and with a cylinder ratio of 2.8, giving practically equal work in the two stages of compression. If the test pressure is other than 100 lb., and is not more than a few pounds out of the way, it is customary to make the pressure correction to 100 lb., and this should be done before correcting for intercooling. If the effective cylinder ratio is not exactly 2.8 (as it seldom is because of the use of convenient cylinder dimensions) the actual horse power will be very slightly altered, but the *percentage increase* of horse power for that particular pair of cylinders over perfect intercooling with the same cylinders, will be practically identical with the values given by the diagram.

As it is difficult to reproduce such diagrams on a magazine page to a sufficiently full scale, a condensed table of values is appended, from which it will be found easy to plot one's own curves to any desired scale. The values have all been obtained by longhand calculation, using never less than five significant figures and six places of *logarithms*.

CONDENSED TABLE SHOWING INCREASE
OF I. H. P. OF AIR COMPRESSION DUE
TO IMPERFECT INTERCOOLING.

Compound compression from atmospheric to 100
lb. gage pressure. Cylinder ratio, 2.8.

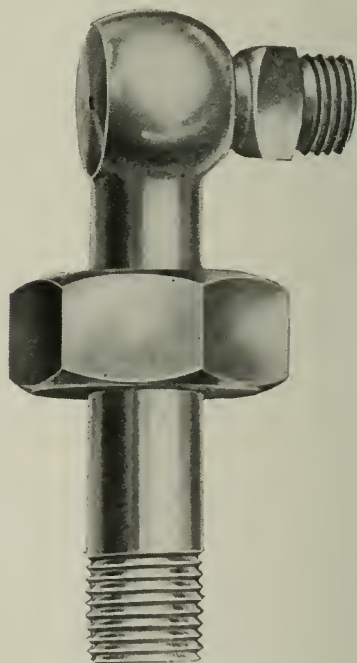
Initial temp. of l.-p. cyl., Deg. F.	Excess of temp. above perfect cooling, Deg. F.	Temp. of air entering h.-p. cyl., Deg. F.	Increase of total I. H. P., %
20	0	20	0.0
60	0	60	0.0
100	0	100	0.0
20	10	30	1.014
60	10	70	0.929
100	10	110	0.867
20	20	40	2.006
60	20	80	1.864
100	20	120	1.728
20	30	50	2.357
60	30	90	2.734
100	30	130	2.558
20	50	70	4.776
60	50	110	4.447
100	50	150	4.136
20	70	90	6.473
40	70	110	6.257
60	70	130	6.019
100	70	170	5.618

In this table only a few values are given, but by plotting these values, first as in Fig. 2 and then as in Fig. 1, all the intermediate points in each diagram may be plotted into the other diagram, finally arriving at such a set of curves as that shown in Fig. 1. In such a form it is possible to include all intermediate values because of its open construction; while Fig. 2, although giving to the eye perhaps a better men-

tal picture of conditions than Fig. 1, does not admit of any more intermediate values without undue crowding.

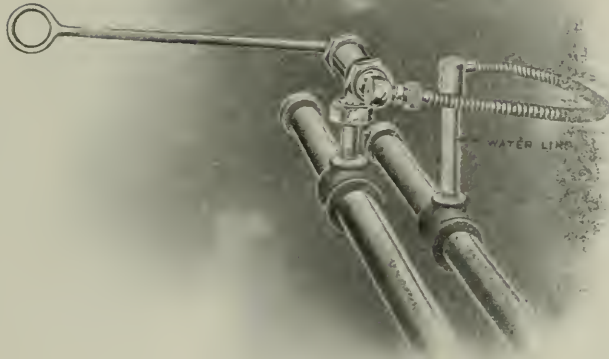
It is interesting to note that with no intercooling at all, the excess horse power is close to 18 per cent. At first thought it would seem that this percentage would vary with different low-pressure initial temperatures; but this means only that with different initial temperatures it requires a different number of degrees excess temperature to represent no intercooling at all, and these different excesses of temperature all correspond to about 18 per cent. excess horse power, and again correspond to the respective initial temperatures.

Another, visual, effect of defective intercooling is the raising of the intercooling pressure. This is due to the increase of volume of the warmer air entering the high-pressure cylinder, and it is this increase of pressure and increase of volume of air handled that increases the horse power.—*Industrial Engineering and Engineering Digest*.



THE TURBO-HUMIDIFIER

The desirability, and in fact in many cases the necessity, of controlling not only the temperature but also the humidity of the atmosphere in which industrial operations are to be carried on is coming more and more to be



THE TURBO-HUMIDIFIER AND CONNECTIONS.

recognized and provided for. Artificial heating of factories in winter, and, so far as possible, the cooling of them in summer is imperative; but it is quite desirable to control also the amount of moisture in the air, not only for the comfort and efficiency of the operatives, but also for the profitable manipulation of the materials of manufacture.

This is especially important in the textile industry, and it was quite in the natural order of things that an effective humidifying apparatus should have originated where the need of it was most urgent. The turbo-humidifier here illustrated is the invention of Mr. Albert W. Thompson, Mechanical Superintendent of the Amosking Manufacturing Company.

Fig. 1 shows the complete humidifier full size. The lower end is connected to the air pipe system, a suitable pressure being about 65 lb. gage, and the side branch to the water supply, the moisture laden air being discharged from a small hole in the center of the flat face opposite the water connection. It is not necessary to place the humidifier in a vertical position, as it works equally well however located.

The humidifiers are distributed about a large room or factory as judgment and experience may determine, Fig. 2 being a sketch of a typical mode of attachment. The handle at the left controls the water admission, and can be

adjusted with great nicety according to the varying requirements.

This humidifier is a distinctly new departure in this line of apparatus. The objects sought in the invention were simplicity, efficiency, ease of adjustment and low installing and operating cost. The regulation may be at one point for a room or a group of rooms, or there may be individual regulation at each head. The chief aim was to secure complete vaporization of the water and in this respect there can be no comparison with the numerous class of atomizers or injectors.

The air, as was said, is delivered to the humidifier at a pressure of about 65 lb., while the water requires no pressure. The air passes through tangential passages surrounding a conical pointed hollow bushing through which the water emerges. The tangential jets of air produce a vacuum at the point of the bushing and also cause a rapid rotation of the water jet as it emerges, the centrifugal motion completely pulverizing the water and intimately mixing it with the air, the product as delivered being comparable with steam but without the heat.

It is recommended that an independently driven air compressor be provided where this system is installed. This will permit complete humidification of the atmosphere before work

begins, and its proper maintenance at all times. The air pipes may be provided with tees or otherwise where connection can be made for taking off air for other purposes, and incidental uses for the air are almost sure to develop.

The apparatus is made by G. M. Parks Company, Fitchburg, Mass., who will supply more complete information concerning it upon application.

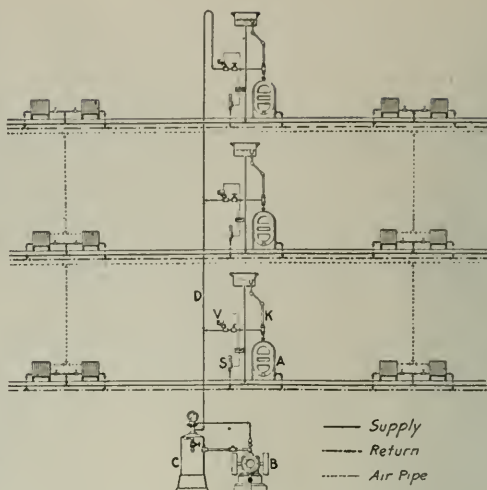
COMPRESSED AIR TO CIRCULATE HOT WATER

An illustration of the system designed by Herman Kraus, engineer of the German Museum in Munich, is shown herewith. The compressed air is introduced into a riser leading directly from the heater, or hot-water boiler to the expansion tank, where the air escapes and the water is returned through the radiators to the heaters. The supply of air may be controlled by the outside temperature or, as shown in the drawing, by the temperature of the return. A thermostat is connected with the return and controls a pressure-reducing valve on the air supply.

The compressed air is supplied by an electrically-driven compressor which is automatically controlled according to the pressure in the air tank. From the tank, the air passes through the reducing valve and enters the riser through a specially designed nozzle.

In the sketch *A* represents the hot-water heater, *B* the air compressor, *C* the air tank, *D* the air-pressure piping, *V* the reducing valve, and *S* the thermostat. It may be noticed that an expansion tank *E*, and a hot-water heater are shown on each floor. From each expansion tank there is a connection to atmosphere so that air may escape without having the opportunity to enter the radiators and interfere with the operation.

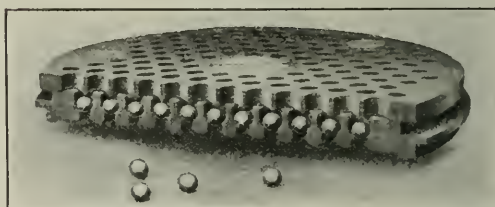
In the state sanitarium at Hütteldorf, Vienna, ten large buildings are equipped with this system. The installations were made five years ago, and according to reports have given excellent satisfaction. Some of the advantages claimed by the inventor are adjustment of the rate of flow according to the outside temperature or to the temperature of the return, the possibility of obtaining the necessary amount of compressed air for a full day inside of one or two hours, central regulation, no possibility



HOT WATER CIRCULATED BY COMPRESSED AIR.

of overheating the water in the system and the use of pipes of small diameter.

Any hot-water heating system can be fitted up with the air equipment at small cost. The system is recommended especially for green houses where uniform and high temperature is essential.

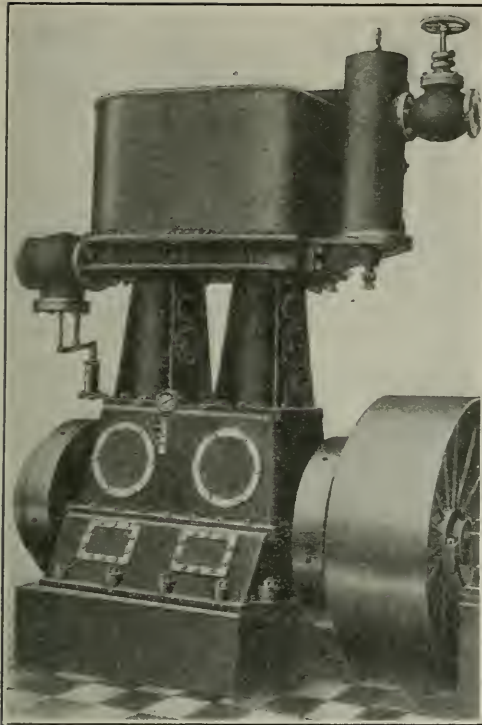


BALL VALVES IN CYLINDER HEAD.

AIR COMPRESSOR WITH BALL VALVES

The illustrations here reproduced from *The Engineer*, London, show the essential features of Scott air compressor, built by Isaac Storey and Sons, Limited, Manchester, England. The compressor here shown is a two stage, belt driven machine with single acting cylinders, which are entirely enclosed in a water tank which contains also the intercooler. The cylinders and tank are mounted on distance pieces, with a closed casing below which is utilized by a system of forced lubrication.

The special feature of this compressor is the ball valves, which are used both for the inlet, through the top of the piston, and for the



SCOTT AIR COMPRESSOR.

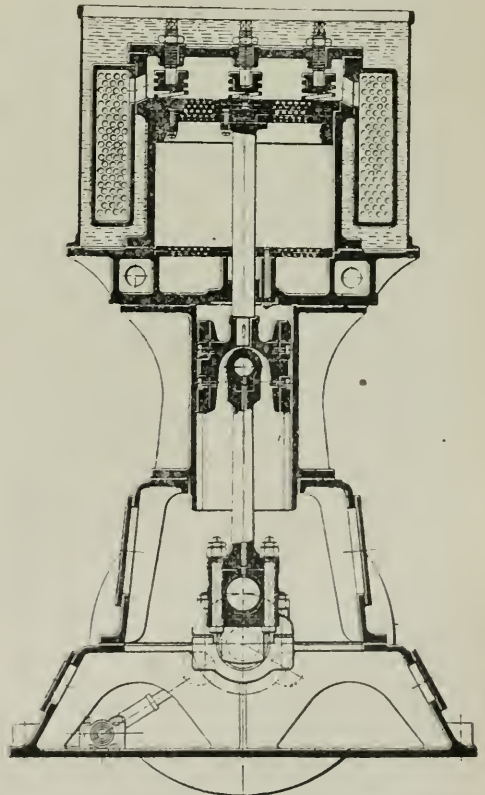
discharge through the cylinder head. The plate over the valves has holes corresponding to those in which the valves seat, but they are so located that the solid portions between the valves come directly over the balls, allowing a lift of only 1-16 in. It is not easily to be believed that all these valves can be all and always air tight.

The intercooler consists of a number of brass tubes expanded into tube plates in the ordinary way, and so arranged that the air is passed through the tubes on its way from the low to the high pressure cylinder, while the whole of the intercooler is immersed in the body of water in the tank.

NEW YORK BARGE CANAL

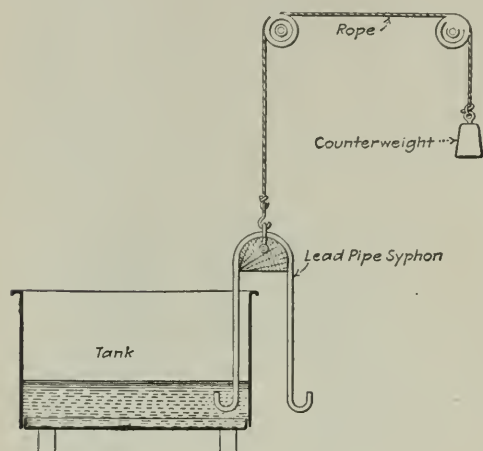
A comparison between New York's \$120,000,000 barge canal and the Panama Canal was made recently by John A. Bense, state engineer of New York. The magnitude of the barge canal is not generally appreciated, Mr. Bense said. The Panama Canal is a great engineering work, but we of the barge canal think that in many ways our project is as

great, if not greater. The barge canal is 540 miles long and embraces between 350 and 400 structures. The Panama Canal is fifty miles long and has few if any structures besides six locks. While the construction is going on navigation is maintained along the barge canal, operations are entirely through contractors, and transportation facilities are not controlled. These difficulties are absent at Panama. In the case of the barge canal vested rights, property interests, legal complications, the need of guarding community interests and the prohibitive cost of acquiring rights so hedge in the engineer that his authority is limited. In Panama these obstacles are not encountered. While the total quantities of construction items on the barge canal are equal to about three-quarters of those on the Panama, the barge canal, including about fifty terminals, is being built for a little more than one-third the cost of the Panama. To supply the canal with water two great reservoirs have been built, the



SECTION OF SCOTT COMPRESSOR.

one at Delta being the larger. It is two miles wide and four miles long. Its capacity is 2,750,000,000 cubic feet. At Little Falls are the greatest series of high lift locks in the world. These five locks have lifts ranging from 32½ to 34 feet and a combined lift of 169 feet, or twice the total length from tide to summit of the Panama Canal. At Oswego is the first siphon lock in America. Contracts to the amount of about \$82,000,000 have been awarded. These cover all but two or three per cent. of the whole length of the canal, and work to the value of about \$56,000,000 has been completed.



A SIPHON ALWAYS READY

The sketch, which seems to require no explanation, comes to us from the Journal of the Chem. Met. and Min. Society of South Africa. The siphon is suspended with a counterweight as shown, and when the liquid in the tank, or any portion of it, is to be drawn the siphon is lowered into the tank as shown. To start the flow it is first necessary to fill the siphon which may be done by suction on the outer end, and then the liquid will continue to flow as long as the outer end is lower than the level of the liquid within the tank. If the flow is continued until the submerged end of the tube is uncovered all the liquid will run out of the siphon, and it will require recharging. It would seem also that in any case there should be some way of choking or stopping the flow of the siphon before lifting it out.

THE MINE TELEPHONE

BY BERTON BRALEY.

"Ting—a—ling—a—ling,"
 You can hear my noisy ring,
 As it echoes in the chambers of the mine,
 When I clearly come across
 With the orders of the boss
 Which are ripping in a volley down my line;
 Though for miles the workings run
 I have hitched 'em up as one,
 I have made the mine a unit by my call,
 From the busy bottom pump
 To the breaker and the dump
 I'm the blooming nervous system of it all!

"Ting—a—ling—a—ling,"
 Hear the message that I fling,
 "There's a cave in Number 20, send a crew,"
 So they listen to my shout,
 And they come and dig us out,
 While without me 'twould be hours before they
 knew.
 On my slender singing wire
 Thrills the warning of the fire,
 I give notice of the vapor's deadly breath,
 And again and yet again
 I have saved the lives of men
 Who would otherwise have met a fearful death.

"Ting—a—ling—a—ling,"
 You can hear my noisy ring,
 With its tintinnabulation on the ear,
 I'm the terror of the shirk
 As I drive him on to work,
 But when danger comes he's thankful I am
 here,
 I'm the foe of all delay,
 And I help to "make her pay,"
 As a master of efficiency I shine,
 From the cellar to the sump
 I can keep 'em on the hump,
 I'm the blooming nervous system of the mine.
 —Coal Age.

A number of mines along the Monongahela river will be changed from electricity to compressed-air as a result of the Cincinnati mine explosion. The Department of Mines, through district inspectors, has ordered the changes. Safety-lamps have also been ordered to be used exclusively in future.

COMPRESSED AIR MAGAZINE

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THE INTERDEPENDENCE OF PUMPS AND COMPRESSORS

It will be noticed that in our present issue the most prominent article is one having to do with the manufacture of pumps for water, and some reader of COMPRESSED AIR MAGAZINE may be moved to remark as to the apparent anomaly. We have to confess that we do not really feel that any apology is required, or even a word of actual explanation to those sufficiently informed, but a gentle reminder as to the actual relations of water and compressed air in mining, tunneling and allied operations may not be out of place.

It is easy enough to say, and we are ready enough to say it, that the most essential agency in all subterranean operations of depth and magnitude is the rock drill, and that without it our modern mines and quarries, our tunnels and aqueducts could have no existence. But we might go further and say that the efficient rock cutting, or, rather, rock rending, devices of us moderns could not have their way unless the water was first removed and kept under control as the work advanced. In perhaps the majority of undertakings of magnitude the rock drill is dependent upon the pump for its right or ability to work. And this is true not only in preliminary work of all kinds but also in the works which are carried on with suggestion of permanency of occupation, as in mining operations in general. It has been noted in our columns quite recently that in some English mines 50 tons of water must be raised to the surface for each ton of mineral, and in the anthracite mines of Pennsylvania it is said that the profits would be increased many times over if the water which must be raised could be sold instead of the coal and at the same price per ton.

The water pump and the air compressor being thus such inseparable companions and such necessary co-operators in their daily work, it would seem to be the most natural thing in the world that the builder of the one as a business should also have the other active and ready on his list for the satisfaction and convenience of the customers to whom he caters.

If the manufacturers of mining machinery, so-called, including all devices employed in the cutting or rending of rock and its manipulation and conveyance, have not included in their detailed list of products one of the most essen-

tial classes of all the apparatus employed, there is no reason why COMPRESSED AIR MAGAZINE should ignore the pump industry.

GAS WELLS FOR AIR RECEIVERS

[The following occurs in a valuable paper entitled "Natural Gas, with Incidental References to Other Bitumens," by I. N. Knapp, M. E., printed in the Journal of the Franklin Institute, November and December, 1912.]

"At Chanute I used, for a few months, the natural gas under rock pressure from two wells for blowing or pumping oil wells and pumping from field tanks. I then put in gas engine driven air compressors to supply compressed air for the same operations.

"The rock pressure of the two wells had fallen from 305 to 125 pounds, and the gas then showed wet. I hitched these two wells on my air line as air receivers or compensators and restored the rock pressure to 290 pounds of air and drove back the salt water. In this way I could, for a while, use compressed air to many times the capacity of my compressors; also, I could shut down my compressors without affecting my field operations. This shows what, I believe, was a new adaptation for a reservoir of rock."

THE CHOICE OF EXPLOSIVES

Black blasting powder is stated to be best suited for work in which a gradual pushing or heaving effect is desired, such as in excavating cuts, quarrying soft rock or stone, and especially in quarries where large blocks of building stone are sought. In order to obtain the maximum efficiency, the charge must be well confined by suitable "stemming." Granulated nitro-glycerin powder is more effective, and gives better results than black blasting-powder, in soft and seamy rock, or in material that does not sufficiently confine the gases evolved. "Straight" nitro-glycerin dynamites, as a class, develop greater disruptive force than any of the other commercial classes of explosives tested by the United States Bureau of Mines; and for this reason they should be used for producing shattering effects, or for blasting tough or hard materials, whenever conditions permit. If the "straight" nitro-glycerin dynamites are found to be too violent for certain classes of work, the low-freezing, or the ammonia dynamites,

which have lower rates of detonation, and hence less disruptive effect, are recommended. The low-freezing dynamites have the advantage of not freezing until exposed to a temperature of 35° F., or less; but, like all nitro-glycerin explosives, after they become frozen, they must be thawed before use in order to insure the most effective results. As the ammonium nitrate used in ammonia dynamite is deliquescent, this class of explosive absorbs moisture more readily than other dynamites, therefore it is necessary that care should be observed when storing this class of explosives in wet or damp places. The gelatin dynamites have been used to a large extent in wet blasting, such as in the removal of obstacles to navigation and in deep workings, and, as a general rule, they are best suited for these purposes.

LOW PRESSURE AIR AND TOO MUCH OIL

The following, from a letter by a correspondent of South African Mining Journal, tells its own story as to the conditions spoken of. The word "jumper" seems to be the local word for the drill steel or bit.

"Personally, I am of the same opinion regarding rock drilling with efficient air power to drive these machines, and as economical as possible; with good air, say, from 85-90 lbs., the miner has a better chance of doing better work, and better footage. I consider 60-65 lbs. air very inefficient, as in the first place the blow of the jumper is not strong enough to drill a hole with clearance for the next jumper to follow; it not alone blunts the jumper quicker but stops you from progress, and in some cases the holes are shorter than others, hence bad enough occurring; the jumper is only fit for use once, the corners are all knocked off, and this makes it impossible for further use. There has been a lot of trouble between the miner and the man in the power house. When the air is bad you ring and ring till you are blue. In not getting any response to air signals, I have come up and found 30, even 40, lbs. registering on gauge, yet the power house in every case logs 80 lbs.; this has been of very frequent occurrence. Trouble has arisen between the miner and drill sharpener; the drill sharpener considers the jumpers are not getting fair treatment, while on the other hand the miner is blaming the air, and

the way the drills are sharpened. I prefer the jumpers sharpened with a square face; this I have found to every advantage, both in collaring and drilling much faster, whereas on the other hand with a jumper having a rounded face, I find difficulty in starting and drilling a hole correctly, also the next jumper not following. Particularly is this so when drilling 7-8 feet hole it has often been the case. Say the diamond being used a second time, what with the jamming and low air pressure, and when it comes to the chisel this won't follow, then you use a half-worn chisel, and probably 6 in. to 9 in. of use you are compelled to abandon the hole, or chamber it, before rigging up again, which is often the case.

"It has happened to me scores of times when I have had to leave the machines, and come to the surface, and ask the man in the power house to give the air receiver a 'tap' the gas has been that bad from the compressor oil, making everyone ill. I have known on one mine where this used to occur regularly once a week, the miner and all his boys suffering from bad headaches, caused through the gas in the air. I complained to the management on three occasions, and finally an investigation was made, and *there were taken 110 gallons of compressor oil out of the air receiver.* On another mine the air gave trouble again; one could not get more than 65 lbs. air, the rock being hard to drill, and using 12 holes for cut and round, this used to take three shifts sometimes before the round was down, and heavens knows we did work to get through. I maintain that unless the air registers 85-90 lbs. the work cannot be done as required."

THE "LITTLE DAVID" RIVETING HAMMER

The half tone shows one of the latest to be perfected of the extensive line of pneumatic tools of the Ingersoll-Rand Company.

This hammer is shorter than those of other makes with a like stroke. It is light, easy to handle, and has a very sensitive throttle control, making it specially suitable for drift-pin work. The valve chamber is independent of the piston chamber, which permits the use of pistons of different lengths without the liability of valve breakages so common in pneumatic hammers where the piston travels through the valve, or where the construction is such that the valve travels in line with the piston and is



LITTLE DAVID RIVETING HAMMER.

shifted by the piston compression. There is only one large port in the cylinder, which is equal in area to the usual multiple port construction and eliminates the liability of clogging.

The grip handle is of liberal size, and has a single lever throttle with a long bearing. The handle is attached to the cylinder by two bolts parallel with the cylinder. This insures perfect locking of the handle to the cylinder and precludes the necessity of using a vise for holding the tool when taking it apart. A single wrench is all that is required and taking apart or putting together again can be quickly done on floor or bench. The sand blast finish on both cylinder and handle prevents the hand slippages with hammers whose surfaces are polished.

The hammer is made in two sizes. No. 60 has a 6 inch stroke and will drive rivets up to $\frac{7}{8}$ inch diameter, and No. 80 has 8 inch stroke, and is suitable for rivets up to $1\frac{1}{4}$ inch diameter.

OBJECTIONS TO HIGH FLASH-POINT OIL

At a meeting of the Association of Certified Mechanical Engineers (South Africa) one of the most important matters discussed was the lubricant of the compressed air cylinders used on the Witwatersrand. It was maintained that considerable quantities of harmful carbonaceous matter was liberated when the high flash point oil was used, and the air containing these impurities was liberated at the rock drills and pumps worked by compressed air, while the miners were at work. It was generally agreed that better lubrication could be obtained at much less expense to the mines by the adoption of oils having a lower flash point than that now demanded by the Government Mining Department, and that the use of such better oil would result in pure air and greater efficiency. The adoption of the "high flash point oil" was a "scare" movement after several explosions had taken

place in air compressors, but as the regulations now in force required the necessarily stringent hourly inspection of the temperatures of various parts of air compressors, the necessity for oils having a high flash point no longer existed. It was therefore unanimously agreed to apply to the Government Mining Engineer to allow the use of better lubricants, which while being cheaper were more efficient than those now demanded under the Mining Regulations, and would not deliver carbonaceous matter to the air mains or parts connected therewith.

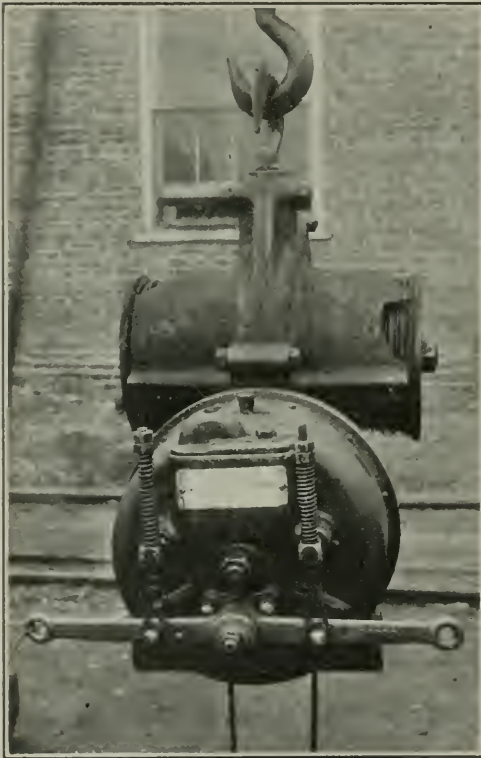


FIG. 1. A VETERAN IMPERIAL HOIST.
IMPERIAL MOTOR HOIST HISTORY

The half tone (Fig. 1) shows an Imperial Motor Hoist at the shops of the Ludlum Steel Spring Company, Watervliet, N. Y., which has been in constant use since early in 1906, and is still doing excellent service. It has evidently had its share of accidents as well as inevitable wear. The guard covering the rope drum has been broken off on each side, and some repairs or replacements of working parts

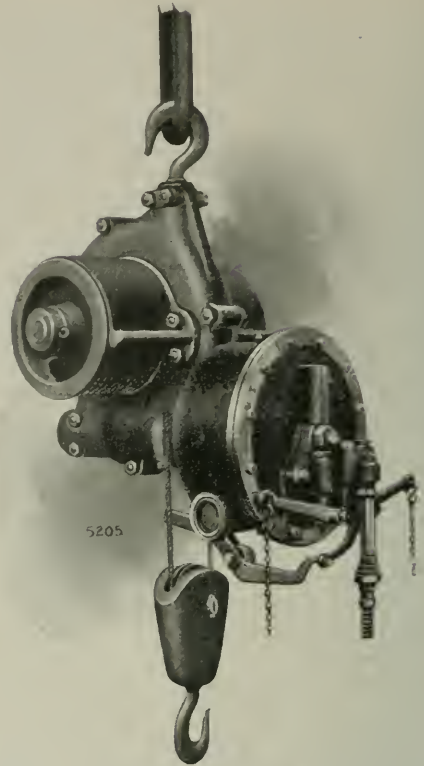


FIG. 2. UP-TO-DATE IMPERIAL MOTOR HOIST.

may have been required, but it is still "on the job."

Fig. 2 is a view of a hoist of this type which is right up to date. It has been improved and redesigned all through, the valve arrangements being quite different in appearance as they are also in fact. The levers for hoisting and for lowering are separate and independent, and each permits perfect and delicate control. If the hoist lever is held open too long by the operator it is automatically provided that there shall be no over-lift and no damage can ensue from that cause. Both the hoisting and the lowering valves are normally always closed, and there can be no movement of the hoist either up or down, except in response to actual pull on the chain, and the load will no more run down than it will run up of itself.

While the rock drill has been constantly developing into increased efficiency, the associated means connected with the handling of the materials liberated by it have not been able to keep pace with it.

THE DIFFUSION OF GASES

If two gases be separately imprisoned in a vessel with a central sliding door between them, then when the door is removed, those molecules which were by the door will begin to diffuse into the next compartment. This power of diffusion varies inversely as the square root of the density of a gas. Thus if the two gases are oxygen and hydrogen the densities of which are 16 and 1, their diffusive energy will be as 1 to 4, and the first molecules of hydrogen will penetrate 4 ft. into the mass of oxygen in the same time as occupied by the molecules of oxygen in penetrating only 1 ft. into the mass of hydrogen. This diffusion runs counter to other influences and enables oxygen to find its way to the floor of a mine in spite of the superior gravitational pull upon the carbon dioxide. Thus diffusion and temperature-produced currents mix up the atmosphere, preventing gravitational stratification.

Since 14 cu.ft. of air weighs one pound and the atmosphere weighs upon each square inch about 15 lb. the height of the atmosphere, were it uniformly dense vertically, would be about 28,000 ft. And since its content of carbon dioxide is one in 10,000, this gas would cover the earth's surface to the depth of nearly three feet. No small animal could live at the sea level.

That we owe mixture to diffusion can be shown by removing the heat which gives to gas molecules this energy of motion. Gases liquify at different pressures and temperatures, and air can be separated into its constituents by compression at a very low temperature, the more easily liquified gases being drained off before the less easily liquified gases lose their gaseous state. The reverse effect, or distillation, has long been employed to separate mixed solids and liquids.

At a velocity of 1920 ft. per sec., a gas molecule, starting upward from the earth would ascend for

$$1920 \div 32 = 60 \text{ sec.}$$

In that time it would reach a height of 161² ft., or

$$3600 \times 16 = 57,600 \text{ ft.}$$

or 11 miles, which would be the depth of the atmosphere for a gas of that molecular velocity. The moon possesses little or no gas because its gravitation is insufficient to restrain the molecular energy with which gaseous molecules travel from it. With such a view of

molecular gaseous energy it is obvious that gases cannot be much influenced by such movements as can be mechanically impressed upon them, and would-be revolutionaries in the engineering world would do well first to acquire a knowledge of some of the basic laws against which they may be running counter.—*W. H. Booth, in Power.*

HUMPHREY PUMP APPLICATIONS

Wide suggestion as to a further range of uses for his internal combustion pump was given by Mr. H. A. Humphrey in the course of his second lecture on this subject at the Royal Institution.

Mr. Humphrey said that in the application of his pump to the generation of electric energy the water was forced through an ordinary turbine, and brought back to the pump to be used over and over again, thus forming an hydraulic coupling between the gas explosion and the electric generator. In a battery of pumps the water was first delivered into large air vessels; these were interconnected both by air pipes above and by water pipes below, so that the pumps were all working in parallel, and any one pump might be stopped without interfering with the working of the turbine, to which the battery was supplying water. The complete control of the pumps from the switchboard and the freedom from the cyclic irregularities found in ordinary gas engines were great advantages. The special type of Humphrey pump for such work had a solid piston between the hot gases and the water surface, so that much more rapid action was possible, and a large power could be obtained from a pump occupying a comparatively small space.

Another application of the pump was in the propulsion of ships. The correct principles upon which this application could be made were described. In one type of Humphrey pump the water flowed continuously through the pump and received a number of forward-impulses due to gas explosions at regular intervals. All the forces arising from the acceleration of water columns might be completely balanced; and one of their advantages for ship propulsion was that they would not cause vibration. A third application was in compression of air or other elastic fluids. Experiment has shown that an air compressor could be made absolutely self-regulating at all

pressures, such as were required for the blowing of blast furnaces, and as blast furnace gas could be used to work these compressors the arrangement should prove economical. Pumps for acid liquids and pumping from a deep well were described, and also an arrangement of balanced pumps, afloat on a barge, for delivering large quantities of water from a tidal river.

The first series of pumps took in water at the combustion chamber end and delivered it at the other end of the play-pipe. When modifications were introduced, making it possible both to take in and deliver water at the distant end of the play-pipe, it became possible to substitute for an oscillating column of liquid an oscillating solid piston of the same weight. In pumps where the liquids and gases were in contact the rate of retardation of the liquid during compression of the gas must not much exceed that figure corresponding to the rate of acceleration due to gravity, else liquid particles detached from the surface would rise freely into the gas space and spoil the thermal efficiency. This limitation did not apply in pumps having solid pistons, and to show what could be done in speeding up such a pump the lecturer mentioned that an experimental solid piston pump had been run at a speed of 193 cycles a minute.

DANGEROUS UNDERGROUND GASES

Dangerous underground gases include those that exert a poisonous or depressing effect on the human system and those that form inflammable or explosive mixtures with air.

In the air of properly ventilated mines operating under normal everyday methods, such an excess of carbon dioxide or such a deficiency of oxygen as would in itself cause harm is seldom encountered. However, at the working faces of some mines and in old workings there may be a deficiency of oxygen and an excess of carbon dioxide, as compared with normal mine air, that will prevent lamps from burning and be prejudicial to health. In addition, powder smoke may linger and the air may be so warm and moist that bad effects will be experienced by the miners.

Harmful proportions of carbon monoxide, hydrogen sulphide, and oxides of nitrogen are rarely present in mine air except at working faces where explosives have been fired. At working faces, however, as mentioned above,

extremely harmful proportions of gases produced by blasting explosives are liable to be present for some time after a blast. Large quantities of carbon monoxide and carbon dioxide are then often produced; hydrogen sulphide also is sometimes formed. Oxides of nitrogen result from the improper detonation of certain classes of explosives. Immediately after a shot there may escape from the crevices produced by the blast both carbon monoxide and hydrogen so mixed with methane liberated from the coal as to make the mixture extremely inflammable. Carbon monoxide in deadly quantities is also formed by mine explosions and fires. Hydrogen, too, is produced under such conditions.

NOTES

When water is free to drop, it drops downward and not upward, although the half tones showing the Cochrane Separator in our issue for June seem to suggest the contrary. The separator is guaranteed to work all right only when right side up.

Waterwheels of the Pelton type for a head of 2,800 ft. have been installed in a hydro-electric plant at Aruiberg, Switzerland.

Natural gas has been found near Medicine Hat on the Canadian Pacific, the first well throwing out about 2,000,000 feet a day.

It is stated that the Curtiss Motor Company has perfected a motor developing more than 100 horse power with a total weight of only 310 pounds.

An oil engine that in Chicago, St. Louis or New York had produced 75 hp. could do no better than 40 hp. in South America, where the altitude was 11,000 to 13,000 ft. above sea level.

When a fly moves on the window pane it climbs going up and flies if going in a straight line downward. The fly never makes its decent walking on the surface of the glass. Hens invariably scrape gravel with their backs to the sun. Cats never expose their paws to the heat of the fire. In the majority of cases they

bring their left side toward the fire. Dogs, on the contrary, bring their paws as nearly as they can to the point from which the fire proceeds.

The huge Indian span of the old Kentucky and Indiana bridge across the Ohio at New Albany was dropped into the river recently by burning the bolts and fastenings with an oxy-acetylene burner.

Fifty thousand dollars' worth of radium was recently sold by the executors of Sir Julius Wernher, the South African millionaire. This sum was paid for half a gramme (.001102 lb., Avoirdupois).

The first railroad in Iceland is to be built in the next three years, according to a U. S. consular report. It will be about $6\frac{1}{4}$ miles long, extending around the city and harbor of Reykjavik, and costing about \$500,000.

All predictions of past years that coal could not be worked at a greater depth than 1,500 feet, no longer hold water. At the present day, according to W. E. Garforth, president of the British Institute of Mining Engineers, coal is being mined at depths exceeding 3,000 feet. The adoption of a system of long-wall working has solved the question of superincumbent weight. The coal is exposed to this weight for a very short time and places are closed up rapidly.

A pint of gasoline left open in a basin in a room at a normal or average temperature will entirely evaporate in 24 hours. The gasoline vapor is heavier than the air and sinks immediately to the floor and unless it is disturbed by active air current will remain in the room for many hours. One pint of gasoline will make 200 cubic feet of explosive mixture. Without becoming too scientific, it may be said that this gasoline vapor is 7 times more powerful than gunpowder.—*Gas Power.*

Delegates from municipalities in all parts of Europe recently attended a demonstration in London of a new system of road cleaning by a patent dustless motor vacuum road-cleaning machine. It consists of a suction machine containing a stiff brush which revolves at great speed close to the ground, thus creating the suction necessary to remove every particle of dust, mud, or refuse in the road over which it

passes. The refuse is automatically deposited in a covered bin at the back of the car, and the suction is so great that mud is withdrawn from the crevices between the stone blocks with which some roads are laid.

When natural gas is used as fuel under a steam boiler from 40 to 60 cubic feet per horse power hour will be required, while the same power can be developed by the consumption of from 9 to 15 cubic feet in a gas engine, so the use of gas under steam boilers at power plants is not to be encouraged, if, indeed, it should be permitted.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MAY 6.

1,060,588. UNLOADING DEVICE FOR PUMPS. EDWARD H. DEWSON, New York, N. Y.

1,060,594. PUMP. WILLIAM U. GRIFFITHS, Philadelphia, Pa.

1,060,613. SLACK-ADJUSTER. JOHN OSBORNE MARS, Omaha, Nebr.

1,060,650. DIFFERENTIAL-PRESSURE GOVERNOR FOR PUMPS. WALTER V. TURNER, Edgewood, Pa.

1,060,651. OZONE-GENERATOR. ANDREW L. VAN PATTEN, Los Angeles, Cal.

1,060,815-6. PUMP. RALPH B. CARTER, Haworth, N. J.

1,060,826. COMBINED PNEUMATIC LIFT AND FORCE PUMP. FRANKLIN OSCAR DE HYNEL, San Antonio, Tex.

1,060,828. MILKING-MACHINE. HENRY DROUT-LEGE, Ponsonby, Auckland, New Zealand.

1,060,852. VACUUM MASSAGE DEVICE. FRANK O. PARKER, Washington, D. C.

1,060,854. PNEUMATIC WHEEL. NIELS PETERSON, Teton, Idaho.

1,060,964. VACUUM-CLEANER. JAMES T. ATWOOD, Rockford, Ill.

1,060,935-6-7. CENTRIFUGAL AIR - PUMP. FRANZ JOSEF PETERMOLLER, Berlin, Germany.

1,061,034-5-6. PNEUMATIC-DESPATCH-TUBE RECEIVING-TERMINAL. BIRNEY C. BATCHELLER, N. Y., New York.

1,061,142. FLUID PROPULSION. NIKOLA TESLA, New York, N. Y.

1. A machine for propelling or imparting energy to fluids comprising in combination a plurality of spaced disks rotatably mounted and having plane surfaces, an inclosing casing, ports of inlet at the central portion of said casing and through which the fluid is adapted to be introduced to the axial portions of the disks, and ports of outlet at the peripheral portion of the casing through which the fluid when the machine is driven by power, is adapted to be expelled, as set forth.

1,061,181. AIR-COMPRESSOR. JUSTUS R. KINNEY, Dorchester, Mass.

3. In a device of the class described, the combination of a casing having two piston chambers therein, the outlet from one communicating with the inlet of the other; and rotary eccentric pistons in said chambers so positioned relative to each other that one will cut off the inlet to the second piston chamber while the piston in the first chamber is compressing.

1,061,203. HAMMER OPERATED BY COMPRESSED FLUID. CHARLES H. SHAW, Denver, Colo.

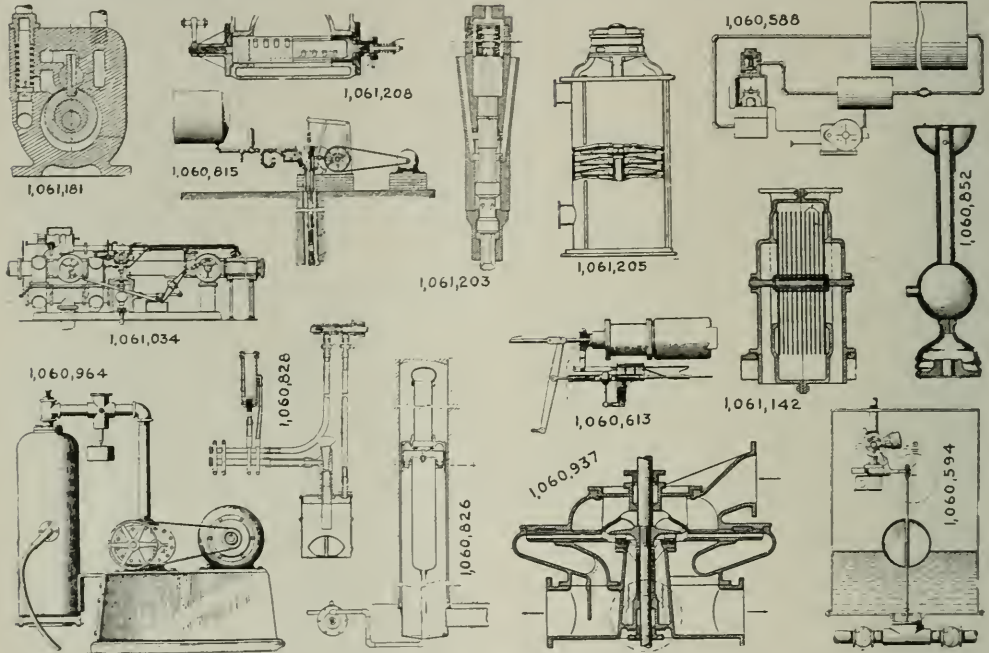
- 1,061,205. APPARATUS FOR PROPELLING FLUIDS. IRA H. SPENCER, West Hartford, Conn.
 1,061,208. GOVERNING DEVICE FOR FLUID-COMPRESSORS. CHARLES WAINWRIGHT and FRED J. CARNEY, Erie, Pa.

MAY 13.

- 1,061,292. DUST AND FUME ARRESTER. JOHN P. HUNDRUF, Riverside, and WILLIAM G. ALLEN, San Francisco, Cal.
 1,061,313. ARMORED PNEUMATIC TIRE. WILLIAM ROBERT MOPPISON, Chicago, Ill.
 1,061,350. STUMP-BURNER. WALTER CLIFFORD BECKHAM, Paxton, Fla.
 1. A burner of the character described comprising an elongated body of U shaped form in

means responding to the removal of an article from the table for causing the admission of pressure beneath the table to elevate it a predetermined distance, means for reciprocating said arm and means actuated by the reciprocating arm for establishing and interrupting suction through said suction device.

- 1,061,537. VEHICLE - WHEEL. LUCIEN R. GRUSS, San Francisco, Cal.
 1,061,539. APPARATUS FOR ADMINISTERING NARCOTICS. GEORG HAERTEL, Berlin, Germany.
 1,061,689. GOVERNING MECHANISM FOR CENTRIFUGAL AIR-COMPRESSORS. RICHARD H. RICE, Lynn, Mass.
 1,061,788. ROTATING MECHANISM FOR ROCK-DRILLS. CLARK J. SMITH, Ottumwa, Iowa.



PNEUMATIC PATENTS MAY 6.

cross section provided with a cylindrical extension upon one end, a plate connecting the side walls of said body at the inner end of said extension, the longitudinal edges of the U shaped portion of said body and the edge of said plate being adapted for engagement with a tree stump, a fuel bed supporting grate arranged between the side walls of the body at its lower end, an air blast pipe connected to said body to supply air to the fuel bed, and a draft pipe connected to the extension of the burner body.

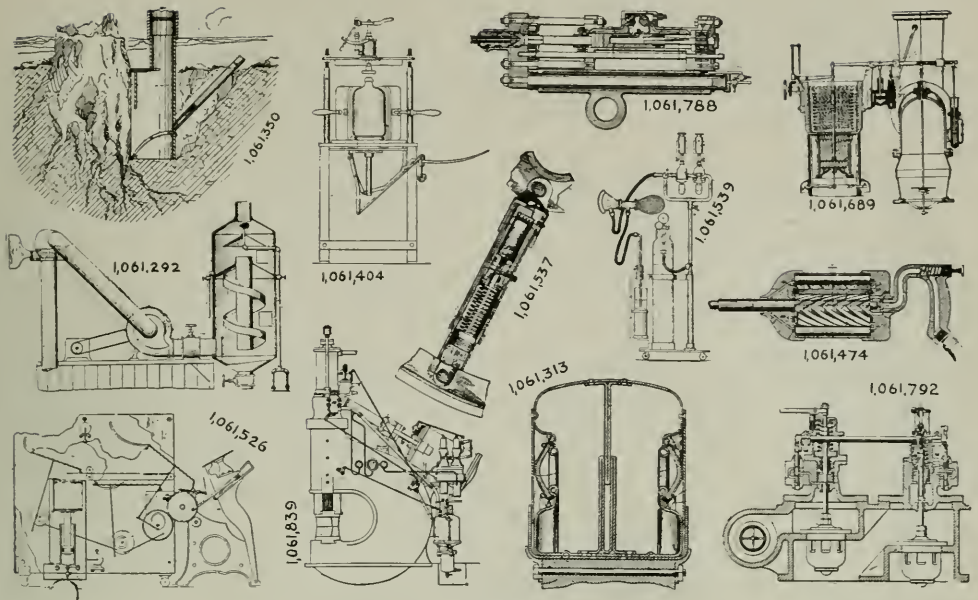
- 1,061,404. GLASS-BLOWING MACHINE. JOHN RAU, Indianapolis, Ind.
 1,061,474. POWER-DRILL. WILLIAM HARTEL, Cleveland, Ohio.
 1,061,526. FEED AND DELIVERY ATTACHMENT FOR PRINTING-PRESSES. SAMUEL W. CORTISSOZ, Philadelphia, Pa.

1. Apparatus of the class recited comprising a table operated through the instrumentality of pressure, said table containing articles to be fed, means for supplying pressure beneath said table for elevating the same vertically, a horizontally arranged endless conveyor, a reciprocating arm equipped with a suction device for transferring one at a time said articles from said table to the conveyor, a pneumatic device for relatively separating said articles prior to transfer, valved

- 1,061,792. ELASTIC-FLUID TURBINE. GEORGE WESTINGHOUSE, Pittsburgh, Pa.
 1,061,839. FORGING-PRESS. HUGO HAISS, Marietta, Pa.
 1,061,900. COMBINED HAND AND AIR BRAKE. WILLIAM J. CLELAND, Watertown, N. Y.

MAY 20.

- 1,061,969-70. COMPOUND STEAM - PUMP. ROBERT C. AUGER, Pittsburgh, Pa.
 1,062,006. CENTRIFUGAL FAN OR PUMP. WALDEMAR HESSLING, London, England.
 1,062,050. WELL-DRILLING APPARATUS. ALFRED C. STEWART, Los Angeles, Cal.
 1. A well drilling apparatus comprising an open-bottomed calisson, means for supplying compressed air to said calisson to maintain a portion thereof free of water, drilling devices located in said calisson and motive means for said drilling devices located adjacent the drilling devices and operating directly thereon.
 1,062,104. PNEUMATIC PLAYER-PIANO. JOSEPH LEISCH, Tryon, N. C.
 1,062,124. AIR-WASHER. SIDNEY RANDOLPH SHELDON, Galt, Ontario, Canada.



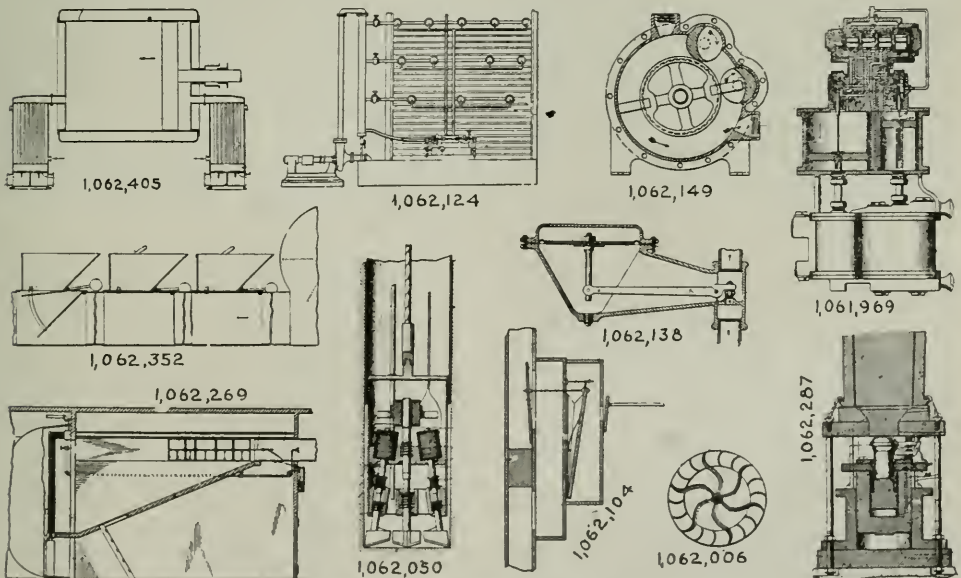
PNEUMATIC PATENTS MAY 13.

- 1,062,138. FLUID-PRESSURE REGULATOR. ROBERT N. BAYLIS, East Orange, N. J.
1,062,149. BLOWER. NELSON E. FUNK, New York, N. Y.
1,062,269. HUMIDITY - CONTROLLING APPARATUS. JOSEPH H. BRADY, Kansas City, Mo.
1,062,287-90. METHOD OF MAKING CASTINGS. DAVID MAXWELL, Detroit, Mich.
1. The method of casting, which includes the

step of imparting a succession of impacts to the casting while pouring, and varying the character of the impacts.

- 1,062,352. PNEUMATIC CONVEYER APPARATUS. HARRY N. MIDDLETON, Philadelphia, Pa.
1,062,405. COMPRESSOR. ERNST WILHELM KOSTER, Frankfort-on-the-Main, Germany.

1. In a compressor, the combination with a compression cylinder and a piston arranged to travel in said cylinder to compress fluid therein,



PNEUMATIC PATENTS MAY 20.

of a cooler having a path one end of which has a constantly open communication with said cylinder, and means connected with the other end of said path, for controlling the admission and delivery of the fluid to and from said cylinder, so that the said fluid will travel through the same path of the cooler both on its way to the cylinder and on its passage therefrom.

MAY 27.

1,062,608. PRESSURE-AIR DEVICE. CHARLES SANDOZ-MORITZ, Yvannes, Switzerland.

1,062,662. ROCK-DRILL TESTER. WILLIAM D. PAYNTER, Grass Valley, Cal.

1,062,665. LOAD - CONTROLLING DEVICE. GEORGE M. RICHARDS, Erie, Pa.

1. In a load controlling device for fluid compressors, the combination of a casing having inlet and outlet portions which connect respectively with the compressor and with a receiver for the compressed fluid, and an escape opening, a check

valve located between the escape opening and the receiver for retaining the pressure in the casing, a valve cylinder located in said casing between said inlet and outlet openings, a load controlling valve located in said cylinder and adapted to open and close said escape opening, a by-pass adapted to transmit fluid pressure from the inlet portion of said casing to said cylinder, whereby the difference between the fluid pressures in the inlet portion and the escape opening of the casing is transmitted to said cylinder to move said controlling valve to close said escape opening, and means for returning the controlling valve when the pressure in said cylinder is reduced, substantially as set forth.

1,062,837. VACUUM CLEANING DEVICE. HERMAN B. MERTZ, Beach View, Pa.

1,062,855. AIR-GUN. ERNEST S. ROE, Plymouth, Mich.

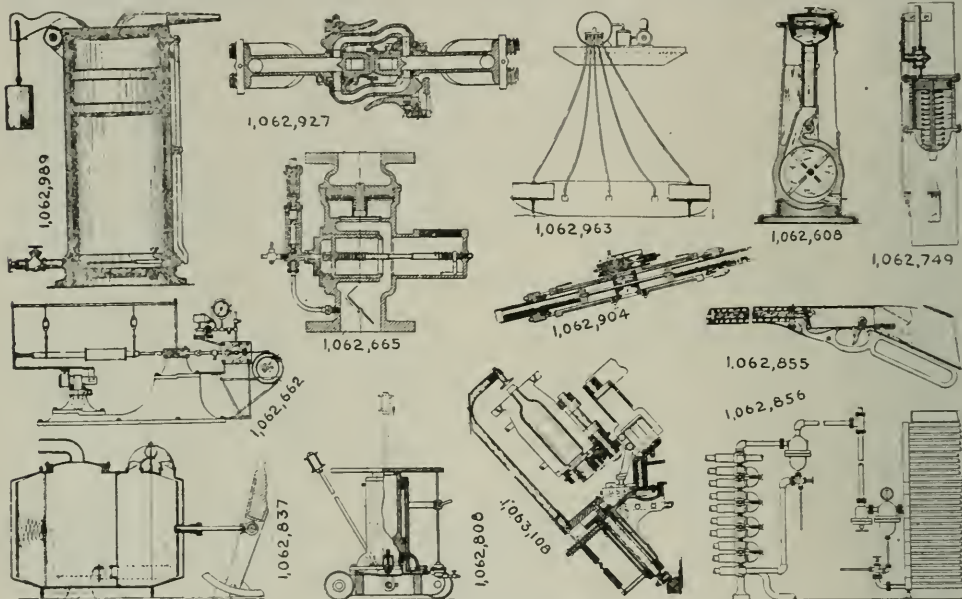
1,062,856. REFRIGERATING APPARATUS. JOSEPH SCHNEIBLE, Chicago, Ill.

1,062,904. FLUID-PRESSURE MOTOR. JOHN FOURNIA, Albany, N. Y.

1,062,927. AUTOMATIC PIPE CONNECTION. JOHN W. ROBERTS, Sarnia, Ontario, Canada.

1,062,963. APPARATUS FOR RAISING SUNKEN VESSELS. THOMAS HECTOR GAWLEY, New Orleans, La.

An apparatus for raising sunken vessels comprising a header adapted for connection to the container of an air compressor, and having a



PNEUMATIC PATENTS MAY 27.

valve located between the escape opening and the receiver for retaining the pressure in the casing, a valve cylinder located in said casing between said inlet and outlet openings, a load controlling valve located in said cylinder and adapted to open and close said escape opening, a by-pass adapted to transmit fluid pressure from the inlet portion of said casing to said cylinder, whereby the difference between the fluid pressures in the inlet portion and the escape opening of the casing is transmitted to said cylinder to move said controlling valve to close said escape opening, and means for returning the controlling valve when the pressure in said cylinder is reduced, substantially as set forth.

1,062,714. LIQUID-FUEL BURNER. ROBERT N. JOHNSTON, Denver, Colo.

1,062,749. PNEUMATIC TOOL. ISAAC W. TOWNSEND, Teague, Tex.

1,062,808. APPARATUS FOR JARRING AND PRESSING GRANULAR MATERIALS. HENRY TSCHERING, Freeport, Ill.

1. In apparatus of the class described, the combination with a cylinder having inlet and discharge passages below, of a piston working in the cylinder, a spring-closed valve and a second valve each controlling the discharge opening when the companion valve is closed, means for admitting compressed fluid below the piston con-

plurality of valve controlled nipples, a plurality of compressed air tanks, means for connecting said tanks in pairs and admitting of their disposition on opposite portions of the vessel to be raised, a plurality of flexible tubes carried by the nipples, a plurality of tubes carried by the tanks, Y-couplings connecting certain of the first with the second named tubes, sealing plates secured in the hatches of the vessel, nozzles extending through said plates and connected to the other of the first mentioned conduits, and discharge conduits also secured in said plates.

1,062,974. OZONIZER. NEVIL MONROE HOPKINS, Washington, D. C.

1,062,989. SAFETY APPLIANCE FOR SAUSAGE-STUFFERS. CHARLES NAEGELEN, Cincinnati, Ohio.

1,063,034. PROCESS OF AND APPARATUS FOR RAREFYING AND COMPRESSING AIR AND GASES BY MEANS OF LIQUID ACCELERATED BY A ROTOR-WHEEL. CARL HERMANN JAEGER, Leipzig, Germany.

1,063,072. AIR - RIFLE. ELBERT HAMILTON SEARLE, Springfield, Mass.

1,063,081. APPARATUS FOR THE PRODUCTION OF AIR-GAS. WALTER THIEM, Halle-on-the-Saale, Germany.

1,063,108. GLASS-BLOWING MACHINE. WILLIAM EMIL BOCK, Toledo, Ohio.

COMPRESSED AIR

MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XVIII

AUGUST, 1913

No. 8



FIG. 1. CUTTING AWAY FOR NEW WHARVES. SYDNEY, AUSTRALIA.

ROCK EXCAVATION AT SYDNEY HARBOR AUSTRALIA

The New South Wales Government dockyard is situated on Cockatoo Island, in Sydney Harbor. It is on the site of a large prison established in the days when British convicts were transported to Australia. The formation of the island was originally quite unsuitable for a dockyard, as the solid rock rose sheer from the water to a height of 60 to 70 feet. By the use of convict labor the rock was gradually cut back, first to permit

the building of graving docks and later to make room for building slips and shops near water level. This work has been and is being continued until at present two-thirds of the total area of 33 acres has been brought to a practically uniform level of about 15 feet above high tide. The two accompanying half-tones show how the work is now being carried on, rock drills being employed, but the arrangements for handling the material being still antiquated and inefficient.

What follows is communicated to Com-

COMPRESSED AIR MAGAZINE by Mr. A. P. Smith, of Sydney, who wishes to make record of his indebtedness to Mr. Debenham, one of the engineers of the Harbor Board for much of the information here given.

SUBMARINE ROCK EXCAVATION.

To make the dockyard and other facilities fully available, and in general to keep pace with the increasing draft of modern ships, it has been found necessary to extensively excavate the harbor bottom in the main channels and along the principal wharfs.

The material for the most part consists of sand and silt resting on a sandstone bottom, which rises at the shores to form the hills which are the chief feature of the harbor scenery. And while in the main channels, suction, bucket and grab dredges are all that are necessary to remove the material, these excavators become useless along the fore-shores where the rock crops up.

To remove the rock several methods have been tried. Drilling and blasting with isolated drills proved too expensive and the Loebnitz rock crushing system was a failure. The machine that has been employed for some years now by a contractor is a rock-chopper, which consists of a large drill, boring 18" holes in diameter, and with this machine no explosives are used, the rock being cut out by a series of holes pitched close together. But the price asked by the contractor for this work has been considered too high by the Harbor Trust, who decided to build and use a drilling and blasting plant on modern lines—a description of which follows:

Four drills are mounted on a pontoon, Fig. 3, whose measurements are 80'x30'x6', on one side of which there is a gantry consisting of seven "A" frames braced together. Along the top of these frames runs an 8"x6" Oregon beam carrying a 40 lb. rail. Another 40 lb. rail rests on a sill on the deck, and these two rails carry the four drill frames which run along the rails on double flanged wheels, the total height of the drill frame being 24 feet. These drill frames can be moved along the gantry to any desired position and clamped, and the drilling machines slide up and down inside these frames, being hoisted or lowered by means of block and tackle taking their lead to one of two winches located at the end of the pontoon. The machines are pinned as desired by attach-

ment to a chain passing behind the machines and fastened to the top of the frame. Two sheaves are situated at the top of each frame, one takes the rope for raising and lowering the machine, and the other a rope for removing and replacing steel.

The plant on the punt consists of two Colonial type boilers, an "A-1" Ingersoll-Rand air compressor, 18x18¼x24, having, at 100 r.p.m., a piston displacement of 656 cubic feet of free air per minute, a steel air receiver, 16' 3"x3' 9", two 10"x6" Marine type Winches with drum and two winch heads, two Tangye pumps 5"x5"x12" which supply the circulating water for the air cylinder jackets and water jets for cleaning drill holes, two donkey feed pumps 4"x4" for boiler feed, two three thousand gallon tanks built in underneath the decks, and opposite the boilers a large coal bunker and tool bench.

The pontoon is moored by four spuds and six kedges, two 4 cwt. each and four 2 cwt. each. The whole pontoon is covered by a lean-to galvanized iron roof.

The drill sharpening is done in a separate punt, 53' 6"x23' 6"x3' 6" fitted with forge and anvil, the forge being worked by a hand blower or hose from the air receiver. This punt is moored along the front of the pontoon and kept off by fenders. The blunt drills are lowered on to the punt and picked up by chain block and tackle which is suspended from a "crawl" running on two rails hung from cantilever supports. By balancing the drill in this tackle it is easily moved about from the forge to the anvil.

The drill outfit consists of four "HA-3" Ingersoll-Rand drills 5" cylinder by 8" stroke. The depth of holes bored is from 7' to 20', diameter of bit; starting, 4½" and finishing at 3½", spacing the holes six feet centres laterally and longitudinally. The drill steel consists of 2½" mild steel shanks with 12" of 3" cruciform (heavy section) bit of high-grade Andrews tool steel welded to the end. This bit is splayed out to a cutting edge of 4½" width.

The explosives used are Rackarock and Gelignite, 60%, the cartridges being 2¾"x6", 9" and 15" long, the charge for a 7' hole being about 5 lbs. A sand pipe is used consisting of a cast steel pipe 8" at the top and tapering to 5" at the bottom with a lug for chain attachment. This is lowered into place after collar of hole is cut, and serves the purpose of keep-

ing the hole free from sand and silt, etc. A $\frac{3}{4}$ " nozzle from the pumps is kept going to free the hole from drillings.

When the hole is completed the drill is withdrawn and a galvanized pipe 3" in diameter is lowered into the hole. The pipe is in sections and the total length is such that it stands above the water level. Down this pipe is passed a 1" hydraulic nozzle which thoroughly cleans the hole out. The cast steel pipe is then withdrawn and the hole charged. These galvanized iron pipes are left in place and recovered

four to thirty-five feet of water. A set of drills consists of one 20', two 30', two 35', two 40' and two 45', the final hole being drilled 2' 6" below the depth desired.

"POTTING FOR PILES."

When there is less than ten feet of sand on top of the rock it is necessary to "pot" the piles into the rock. This is done by a separate drilling plant consisting of a $5\frac{1}{2}$ " and a $6\frac{1}{2}$ " (on order) Ingersoll-Rand drill which is worked by steam in the leaders of the pile frames. The drill frame is raised or lowered



FIG. 2. CUTTING AWAY FOR ROAD TO WHARVES, SYDNEY, AUSTRALIA.

after the hole is fired, any damage being repaired by the tinsmith.

The operation of the drilling pontoon consists in drilling a range of holes along the whole length of the pontoon, charging them and then hauling off the punt and exploding the charges. After this, the pontoon is brought back into place and another range of holes drilled and fired, a grab dredge being used for removing the rock.

The nature of the rock is yellow sedimentary sandstone varying in hardness in different localities. The drilling is done in from

in the leaders by a wire rope attached to the pile frame winch. The drill steel consists of a $1\frac{3}{4}$ " mild steel bar, to the end of which is welded a socket which forms the attachment for a crosshead and pilot bit. This crosshead has four holes into which are cottered four chisel bits 6" face, the chisels being placed radially. The diameter of the hole drilled is about 16" and the usual depth is 4' 6", into which the pile is driven with the aid of a hydraulic jet, the sand afterwards filling in and grouting the pile into place. This is quite different from any other practice known here,

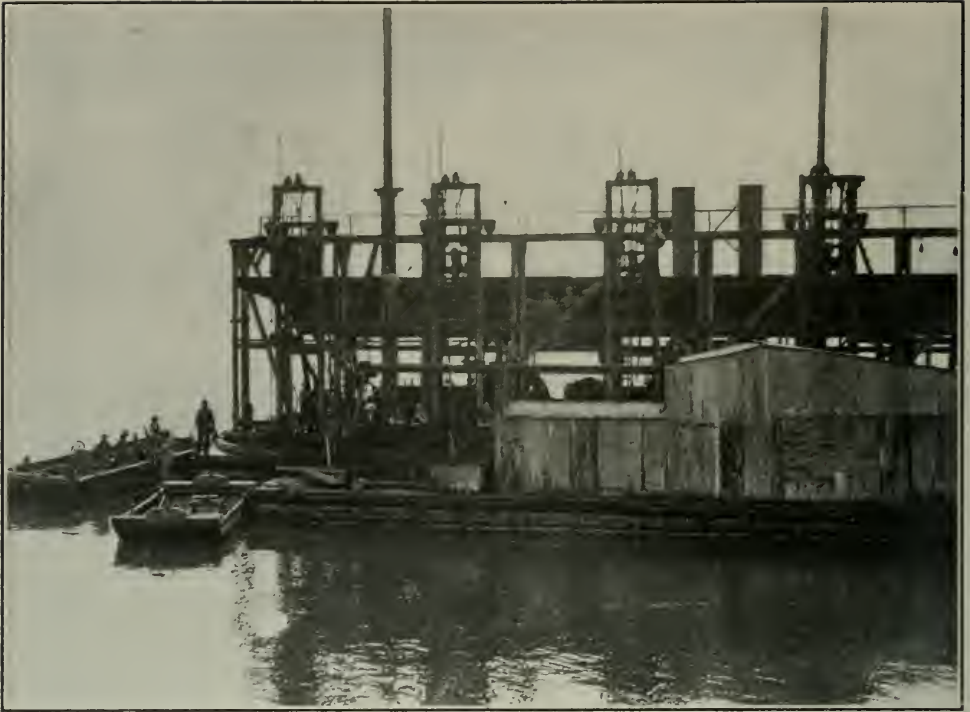


FIG. 3. PONTOON FOR SUBMARINE DRILLS, SYDNEY HARBOR, AUSTRALIA.

the average speed of drilling being from one to three holes a day, depending on the amount of overburden of sand or silt. When more than 2' 6" of sand or silt is met with it is necessary to use a cylinder to keep the sand out of the hole. Hydraulic jets are always used in drilling these holes.

OTHER USES OF COMPRESSED AIR.

Compressed air is also used for driving pneumatic wood boring tools for boring holes in decking and girders and caps, the holes varying in diameter from $\frac{3}{8}$ " to $1\frac{1}{4}$ " and the depth of holes from 8 in. to 2 ft. in hard wood. The rate of boring, $1\frac{3}{8}$ " holes 3 ft. in five minutes of actual drilling time. The same plant, which consists of an Ingersoll-Rand, Type "NF-1" 8x8x8 steam driven air compressor with a 30.1 H. P. Colonial type boiler on a floating punt which is moved about the harbour to the different jobs as required is also used for drilling holes in metal. The tools used are Ingersoll-Rand "Imperial" No. 11 wood boring tools and "Imperial" No. 21 metal boring tools. The same compressor plant is also available for running two "Jackhammers" when it is necessary to drill holes in

rock close to the water, and could also be used for operating sand rammers for ramming concrete later on.

All of the compressed air plant used by the Sydney Harbour Trust is of Ingersoll-Rand manufacture, both for rock excavation on land and subaqueous drilling.

STANDARD RATES OF WAGES (8 HOURS) ON SUBAQUEOUS WORK.

Shift boss	13/—
Drill men, four.....each	10/—
Drill assistants, four.....each	9/8
Engine driver	10/—
Stoker	9/8
Powder monkey	10/6
Blacksmith	10/—
Blacksmiths' strikers, two.....	9/—

Present rates of wages are in a state of transition owing to unsettled labor conditions and they will probably be higher.

A committee has been formed in England for standardizing and co-ordinating the diverse methods in use for determining the degree of pollution of the atmosphere by dust and soot.

THE UNDERGROUND BLACKSMITH SHOP

BY WARD BLACKBURN.

The mining engineer, to meet the increasing cost of operating due to the extension or spreading out of the underground workings, and incidentally to maintain his place in the ranks of the "Scientific Management Engineers," has begun to take advantage of every promised saving in mining operations. One of the latest schemes, and rapidly growing in favor, is the underground blacksmith and repair shop. While the underground shop is not a new idea, it has only been within the past few years that it has received the consideration its efficiency merits. Its adoption has undoubtedly been hastened by the introduction of the light, compact, easily moved power sharpeners, and the attention they have directed toward blacksmithing economies. Now many mines throughout the world are installing complete shops at convenient points underground. Some of the deeper mines, because of transportation difficulties, were the first to feel the need of keeping the rock drills and steel below the surface, but the underground shop has been found to possess so many advantages that it is being utilized even in the shallow mines where the workings are but 200 feet to 300 feet deep.

The chief advantage of the underground shop lies in the fact that transportation costs are reduced to a minimum. The shops are located on the principal levels and there is very little hoisting or lowering of drills or steels necessary. Isolated work on different levels is taken care of by small hoists in old stopes or air shafts, and the main hoisting shafts are left clear for handling the ore. Some mines now sharpening underground report that formerly 30 to 40 minutes were required per shift to hoist and lower steel. This did not represent the total time lost in handling, for in some cases a central shop was used and all steel had to be trucked to and from the shafts on the surface as well as below. The lost time and expense incident to handling steel in the shaft amounted to a considerable item in each month, but in most cases the serious complaint was against the reduction of the time allowed for hoisting ore and waste.

Localization of sharpening has been another factor to consider, for it has been found in some of the larger mines that the varying character of the rock precludes the dressing

and tempering of all the steel in a central surface plant. Steels treated for the rock in one part of the mine would find their way into other parts and cause confusion and sometimes the loss of drill holes. With separate shops installed underground close to the workings, the blacksmith handles steels for only one kind of rock, and having an opportunity to inspect that rock he is better able to turn out correctly dressed and tempered steels. Putting the blacksmith right down in the midst of operations, brings in a personal element which is usually desirable, for, coming in contact with the runners, the smith will endeavor to please them and will take a greater interest and more pride in making his steel stand.

Having the blacksmith shop underground saves a great deal of time in getting steels and insures the drillers having proper steels, when needed. If the machine man breaks a couple of steels it is only necessary for him to send the helper along the level to the shop for more. No time is wasted and work is not held up. This results in more drilling per machine per month. When the steel stays underground it may be distributed more frequently and consequently a smaller stock is necessary.

Under average conditions the advantages of the underground shop are found to be:

Saving in labor and hoisting charges. In deep mines these charges have been found to equal one-half of the total sharpening charges.

Reduction in transportation cost.

Steel kept out of shafts.

More time for hoisting ore and less chance of accident.

Localizing of sharpening. This gives proper steel for each class of work and promotes a better feeling between the runners and the blacksmith.

Steels when wanted and where wanted.

No time lost waiting for steel, either on the part of the machine men or blacksmith.

Less stock of steel required.

Blacksmith as available for repair work and odd jobs.

Men stay underground.

The location of the shop underground will naturally vary with conditions of convenience and ventilation. A place near a hoisting shaft is desirable; often an old stope connected to an air shaft or to the surface by an old pros-

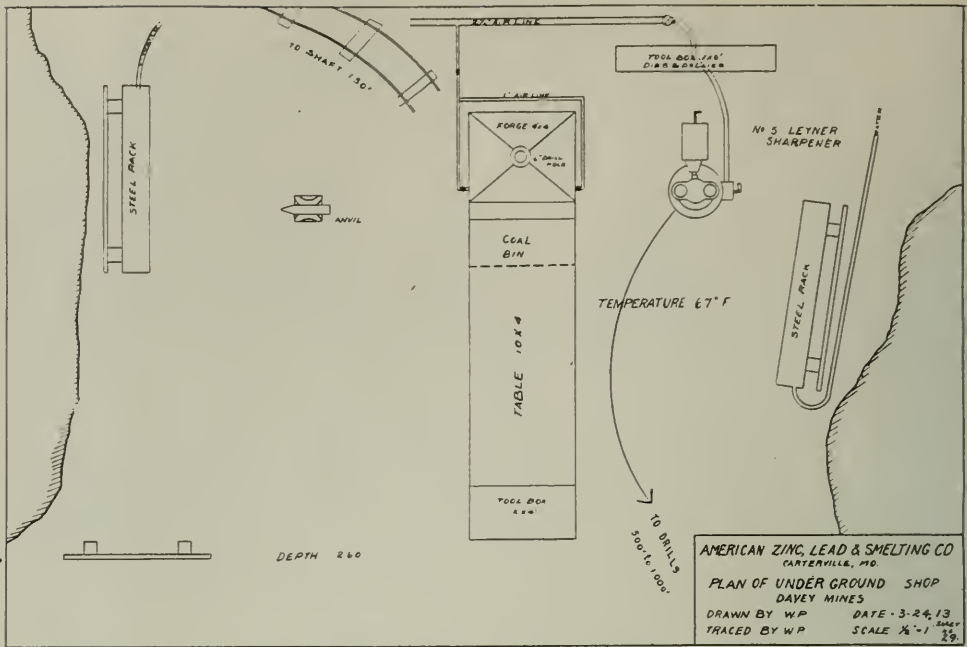


FIG. 1. UNDERGROUND SHOP WITH CENTRAL FORGE.

pecting hole is utilized. Some mines have shops installed in widened drifts or cross cuts. As a rule it is best to stay near a shaft and preferably an updraft shaft.

About the same equipment that is used on the surface is found in the underground shop. As very little steel is now sharpened by hand, the first thing to select is a proper sharpener; a light, compact, easily moved machine, one requiring no foundation is especially desirable, for as development progresses it will be necessary to move the blacksmith shop. The machine selected should make the sharpening as nearly automatic as possible and it should be one easily controlled.

It has been demonstrated that one of the best ways to heat drill steels in the underground shop is by means of an oil furnace and there are now several excellent furnaces on the market designed especially for heating bits. This type of furnace takes up very little room, gives a good uniform heat, and when properly adjusted gives off very little smoke and gas. The oil furnace throws out no obnoxious fumes, for perfect combustion is obtained. The furnace is controlled instantly, and in emergency can be extinguished by simply closing a valve. This eliminates the danger from fire. The amount of oil required is

nominal and the expense correspondingly low.

Suitable tempering facilities are sometimes hard to find for it may be inconvenient to have running water in the shop. In such cases the best results are obtained by having two or more large tanks, using them alternately and keeping the temperature of the water fairly low.

It is essential to provide suitable means for lighting the shop. If this is not done poor steel will result, and, further, the capacity of the shop will be kept low. Either acetylene gas lamps or Tungsten electric lights may be used to advantage, either giving a good light for blacksmithing purposes. It is easier for the blacksmith when sharpening underground to maintain uniform steel where the light is always the same, and when he can always tell within a few shades of color what the heat of the steel is. Ventilation must be carefully investigated, especially if the shop is located any distance from an up-draft shaft. Probably half of the blacksmith shops are located so that no special apparatus is necessary, the exhaust from the sharpener supplying plenty of fresh air and tending to force the heated air from the shop.

An excellent arrangement for an underground shop is shown by the sketch Fig. 1.

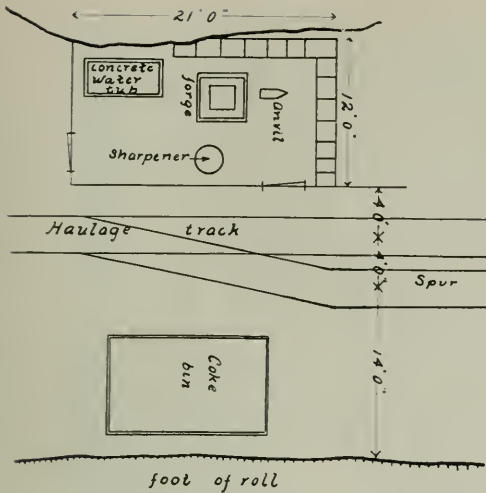


FIG. 2. SHOP AT JOKER MINE.

which was kindly furnished by Mr. J. N. Hansen, Manager, Missouri Mines of the American Zinc, Lead & Smelting Co., Cartersville, Mo. The shop is ventilated by means of a 6-inch drill hole from the surface and a temperature of 67 degrees Fahr. is maintained. Mr. Hansen sums up the advantages of the shop in the saving of hoisting steel, in the

blacksmiths being available for odd jobs of repairing underground and no waiting for steel on the part of the machine men.

Sketch Fig. 2 shows the underground blacksmith shop at the "Joker" mine of Witherbee Sherman & Co., Inc., Mineville, N. Y. Mr. Harry Comstock, Assistant General Manager, very kindly supplied this sketch and also the photographs, the first of which, Fig. 3, gives a good idea of the convenience of location of the shop shown in sketch Fig. 2. Fig. 4 shows the arrangement inside the shop proper. Being close to the shaft no ventilating apparatus is required and the temperature is approximately 60 degrees Fahr.

In the Barton Hill Tunnel property Mr. Comstock has placed the shop on the tunnel level, but near an old shaft connecting to the surface. Although a coke forge is used the ventilation secured is sufficient to carry off all fumes and maintain a temperature of about 70 degrees Fahr. Fig. 5 is a photograph of this shop, and with the sketch shown in Fig. 6 gives a good idea of a desirable arrangement of forge and sharpener. Both shops shown are lighted by incandescent lights, a lamp being placed directly over and in front of the crosshead of the sharpener so that the operator can watch the forming of the bit.



FIG. 3. SHOWING CONVENIENT LOCATION OF SHOP.



FIG. 4. INTERIOR OF SHOP IN JOKER MINE.

The Witherbee Sherman Co. installed the first sharpener underground early in 1912, and since then has purchased three more machines, Mr. Comstock's statement being that "The underground sharpener is proving very satisfactory and we would not consider any other arrangement. The costs are lower and the shop is convenient to the work." He has carefully prepared detailed cost sheets showing the total cost of sharpening per machine drill per month in the underground shop to be \$8.20 over a period of nine months. The total cost of sharpening per drill per month for the central plant located on the surface, using backing block sharpeners, was \$11.48 over a period of eight months.

From present indications it appears that in the near future an increasing number of mines will adopt the underground shop. Only one mine is known to have re-established the central shop on the surface after sharpening underground, and the reasons for so doing were stated to be because of the peculiar distribution of the work, it being possible to sharpen for only a few drills at any one place underground.



FIG. 5. BARTON HILL TUNNEL SHOP.

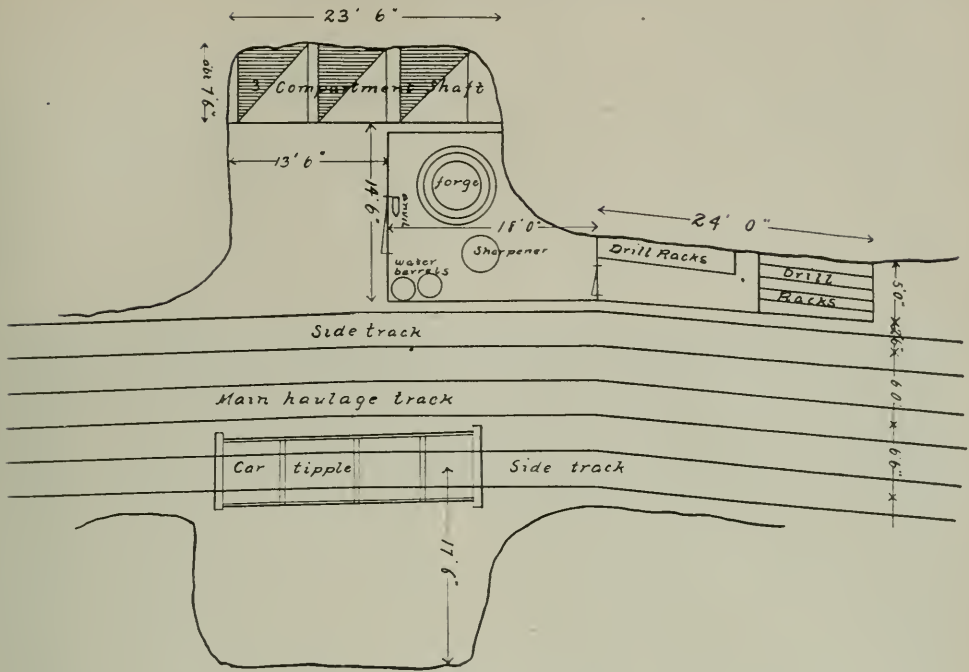


FIG. 6. DESIRABLE LOCATION OF FORGE AND SHARPENER.

EFFICIENCY IN MINING DRILL

BY ANDRE FORMIS.*

In consequence of the increased cost of labor and supplies in the process of mining it has become advisable to investigate the various steps in the production of tonnage with a view to reducing waste factors to a minimum. The paper submitted this evening aims to bring out a discussion on the subject of rock-drilling, the most important of the underground operations.

Considering that the labor factor in mining is about 75% of the total cost, it is evident that the savings effected in this item are proportionately of greater importance than in the matter of the other 25% of the cost. However, owing to the nature of this larger factor it is also much more difficult to accomplish any results with it, partly on account of the evident distrust of the so-called old-time mining captains of anything suggested by a technical graduate, partly on account of the inertia of labor itself, and partly on account of the natural hesitancy of some mine managements to permit anything that may seem a radical

departure from ancient and honorable customs. Yet it can be shown by actual tests, supplemented by correct cost figures—by these I mean costs based on observed and recorded facts and not pro-rated costs—that material savings are easily made without departures in any manner radical in underground practice.

In order to arrive at a correct analysis of any set of conditions it is of course important that the observations of these conditions be as accurate as possible. It is also obvious that a long continued set of observations is more nearly correct than a short one.

In the practice of rock-drilling many different methods are employed, many sizes and shapes of drills are used. Some of these drills are better than others; sometimes, perhaps, one only is the best for a certain class of work. Careful study and patient investigation are required to come to any definite conclusion. The selection of the drill depends on a large number of factors, the most apparent of which are:

1. Hardness of the rock to be drilled.
2. Irregularities of the rock, causing the steel to bind in the holes.
3. Diameter of drill cylinder.

*Read at meeting of the Copper Country Club, March 8, 1913.

4. Piston stroke, if any.
5. Weight of moving parts.
6. Effective blow.
7. Total weight of drill.
8. Depth and diameter of holes to be drilled.
9. Style of chuck.
10. Shape of bits.
11. Use of water in holes.
12. Hollow steel with water or air jet.
13. Wages of miners.
14. Cost of power.
15. Various other factors, depending on locality, etc.

Each of the foregoing factors goes to determine in a manner the proper drill to be used. What appears to be the proper drill having been selected, first an investigation of the amount of air it consumes should be made; second, a time study of its operation.

For the first of these studies may be used the graphic air-flow meter which has been perfected by the General Electric Company which measures in cubic feet the air consumed by any device connected to it.

One of these meters was installed at the property with which I am connected. The meter was first used on the 1900 foot level to measure the amount consumed by a R 3 drill and a Butterfly drill No. C110. Only one drill was working on the line at a time. A recording air-gage was also connected to the line, to ascertain the air-pressure near the drill for comparison at any instant with the graphic flow-meter records.

For a fairly accurate time study of the operations of the drill, nothing more is needed than a watch and a note book. Mr. R. T. Dana and Mr. W. L. Saunders in their work on rock-drilling have published a formula which permits of a set of short observations being used for an estimate of drilling performance. The formula is:

Time to drill one hole = $(e-fd) D/f - (l-g-k)$ in which the quantities signify as in the table following. The table includes also the figures obtained at our mine.

e=average time to change steel.....	our figure, 4.00 min.
d=average time to drill one foot.....	our figure, 4.87 min.
l=average time to move drill.....	our figure, 16.00 min.
g=average time to set up drill.....	our figure, 12.00 min.
k=average time to blow, blast holes, etc.....	our figure, 24.00 min.
D=depth of holes in feet.....	our figure, 8.1 ft.
f=length of feed.....	our figure, 2 ft.
fd=time to drill length of feed.....	our figure, 9.6 min.
Number of hits per hole.....	our figure, 4.0

Then if 540 is the number of working minutes per day shift, the number of holes per day shift=

540

(e-fd) D/f— (l-g-k)

It may be seen that a slight difference from average values will materially affect the result.

The time record taken from the chart of a single shift—day shift, January 31, 1913—is as follows:

Drill reciprocating.....	36.5%
Changing steel.....	15.4
Moving drill on post.....	17.5
	69.4%
Mucking out for post.....	10.7%
Time lost going to face.....	4.1
Getting drill steel and water.....	2.2
Cleaning and charging holes.....	2.8
Blasting.....	2.9
Blowing smoke.....	7.8
	30.5%
Number of holes per shift.....	6
Feet drilled per shift.....	40.5 (medium hard amygdaloid)
Cutting speed.....	0.205 ft. per min.

The air pressure was about 96 lb. absolute, the consumption of air around 110 cu. ft.—for the C110 drill 85 cu. ft.

From this time study it appears that the first three factors, amounting to 69.4%, are inherent in the operation of the particular drill and cannot well be reduced. The other factors, amounting to 30.5%, may be reduced for the benefit of the former,—that is, for more actual-drilling time. This may be accomplished by a change in the method of drilling holes or by employing additional labor to perform part of the 30.5% time-loss, always with the condition that the cost of the additional labor is repaid by the increased footage obtained. In our case it is not.

There is always the question of convenient blasting. This is best done at the end of the shift, in order to allow the smoke to clear. Blasting is done when the proper amount of holes are drilled for a cut or a square. Any holes drilled in addition will simply be a loss, unless the ground to be broken is so uniform that the effect of blasting may be estimated with certainty beforehand. The mucking-out time may be saved by having the broken material removed between shifts, or by working the drillmen and muckers on alternate 8-hour shifts. Another simple method is to have one party of miners work two adjacent headings, the muckers clearing out the blasted face, while the drills are working on the other face. In the case under consideration a fan cut is used, whatever is drilled being blasted at the end of each shift. With this method a complete square can be drilled with reasonable certainty of breaking the ground.

It is apparent that a considerable number

of factors must be considered in each individual case to reduce the non-drilling factors. It is also a fact that what may be an economical method in one case may not be found to be applicable indiscriminately everywhere. The working out of these problems is the legitimate and logical field of the efficiency engineer, but he must be given a reasonable amount of authority if his work is to be profitable and possible.

new Lexington Ave. subway. The plant is located in a vacant lot and consists of two Leyner Power sharpeners, an air operated steam hammer and three forges in one building and beyond it a small machine shop for which power is supplied by a steam engine operated by compressed air. The air is supplied by Rand Steam Driven Compressors, which also serve to operate the Rock Drills. The air, before being used passes through a



LEYNER SHARPENERS ON THE NEW YORK SUBWAY

S. W. SYMONS.

Though the power sharpener has been used for some years in the big mining districts, and in fact is now considered to be almost indispensable, it is only recently that the general contractor engaged in work of a temporary character has considered its use at all. This is rather surprising in view of the immense economies which can be realized by a properly proportioned and efficient underground installation even when it is not to be permanent. Just such a plant is installed at 131st St. and Park Ave., New York, where McMullan, Snare & Triest are at work on a large section of the

reheater, simple but efficient, consisting of a coil of pipe laid on the ground with a slow burning coke fire inside. The coil is closely packed so as to give a large heating surface and at the same time to control the draft.

One sharpener, of the Leyner type, is used for sharpening steel for the large rock drills which use the standard cross bits, and the other is equipped for sharpening steel for the "Bull Moose" self-rotating Jap drill, of which a great many are being used on this work. The type of sharpener used has proved extremely satisfactory, being both cheap in first cost, easy of installation and in operation rapid and efficient.

It is hardly necessary to describe the sharp-

ener, since the makers issue a bulletin giving detailed description of the working and operation. In this particular installation the operator turns out completed bits from the blank on 1" hollow hexagon steel (for the Bull Moose Drills) at the rate of 60 per hour steadily. Cross bits for the larger drills are turned out almost as fast, and the re-sharpening of steel that has been dulled through use is accomplished a little faster.

The finished steel is stored in racks outside the smith shop and taken to the work as needed on a light wagon which also carries back the dull steels for resharpener. This high average of sixty bits to the hour shows the great economy that can be realized by the use of a power sharpener, besides which the bit turned out is of a far superior character to the hand sharpened bit, the system of forcing the steel into a die and forming the bit to an exact and standard shape with a dolly giving a finished drill bit which will obviously be the most efficient for the class of work on which it is to be used. In this sharpener the steel is held in an air operated vise or clamp, exerting a pressure of several tons, and the red hot metal is forced back into the dies by the dolly, operated by rapid blows from a hammer exactly the same as a riveting hammer. This means that the bit end of the steel is forged to shape and the particles compacted into a limited space while the length of steel is held on a rest absolutely without strain, thus obviating the tendency to crystallize so often experienced with sharpeners where a backing block is used to hold the steel in place.

After the bit has been formed, the grooves to allow the passage of the rock cuttings are made with formers placed in the main vise or clamp which is raised and lowered somewhat like a steam hammer while the steel is turned to present the proper surface. All this is accomplished for any one size and style of bit on any standard cross section of steel without changing a single part of the equipment and by the use of but one lever. When a new style of bit is to be made, or the same bit on another cross section of steel, it is necessary to change the dies and dollies as the case may be, this change taking but a few minutes.

As will be seen from the above notes the McMullan, Snare & Triest Co. have surely demonstrated the economy and practicability of the power sharpener for contract work.

AIR NITROGEN FERTILIZERS

Cyanamid is made by absorbing pure nitrogen in calcium carbide at a very high temperature. Calcium carbide, as is generally known, is the material commonly used to generate acetylene gas. It is made by fusing together lime and coke in an electric furnace. The nitrogen used in making cyanamid is obtained by liquifying air, and allowing pure nitrogen only to evaporate from the liquid air.

Nitrate of Lime is made by blowing air through an electric arc, thereby causing combination between the nitrogen and oxygen of the air. This gaseous product, containing nitrogen oxides, is absorbed in milk of lime, which is then evaporated to dryness.

Hence, in the manufacture of cyanamid, the nitrogen is separated from the oxygen in the air and is fixed in white-hot carbide.

In the manufacture of nitrate of lime, the nitrogen is chemically combined with the oxygen in the air, and these nitrogen oxides are fixed in milk of lime at ordinary temperatures.

Cyanamid is a dry, porous, non-crystalline, dark-colored fertilizer material, which has an immediate but slow and progressive action in the soil.

Nitrate of lime is a granular, crystalline, grayish-white material, which has a quick action in the soil, and is especially adapted agriculturally for top-dressing.

About 25,000 tons of cyanamid is now being made and sold in America per annum. The manufacture of nitrate of lime in this country is still in the experimental stage, and only a few hundred tons have been used for agricultural purposes.

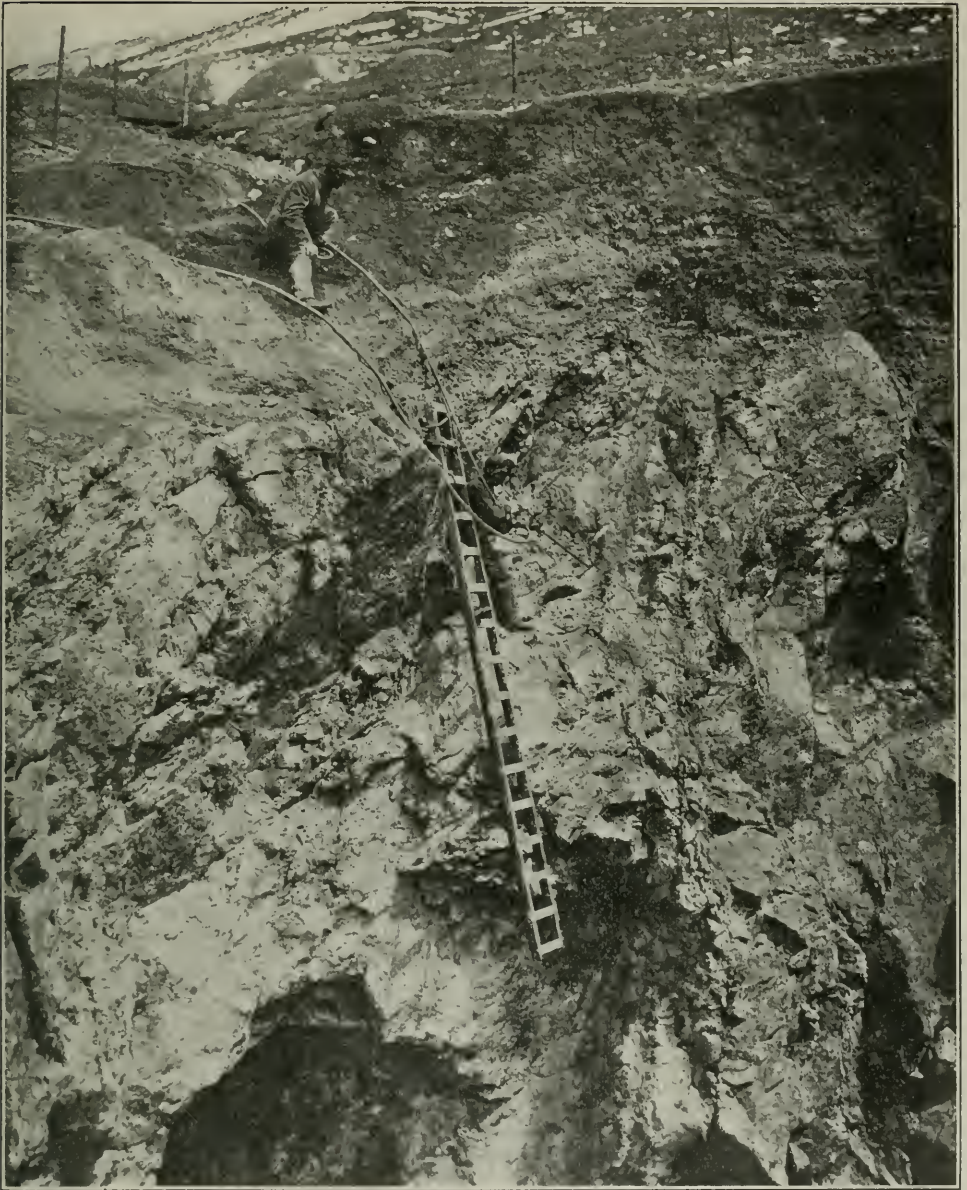
DRILLING IN MID-AIR

BY C. M. HANSEN.*

At the Bullwhacker Copper Company's Mines in Butte, Mont., a great deal of glory-hole mining has to be done which would be extremely difficult, perhaps impossible, with a piston drill. Much of the cutting is done in mid-air in locations that are almost inaccessible, and often where there is no opportunity for a foothold. However, by means of a jack-hammer drill, the miner is able to make good progress with comparatively little difficulty.

A tripod drill would be out of the question for work of this sort and even an ordinary

*Butte, Montana.



TYPICAL STUNT WITH JACKHAMER IN A MONTANA COPPER MINE.

hand hammer drill would be extremely troublesome to operate on account of the difficulty of rotating it in such cramped quarters.

The jackhammer is fitted with an automatic steel-rotating mechanism, so that the miner simply has to apply the tool to the spot to be drilled, open the throttle and the jackhammer does the rest. In many cases the

operator works sitting on a wooden seat in a rope sling let down over the side of the cliff, and one of the accompanying illustrations shows the method of drilling a particularly difficult hole where a rope-suspended ladder had to be pressed into service. Here the operator has one foot on the ladder and is braced against it. There was just sufficient footing

for the left foot on a projection of the rock.

One can get an idea of the dangerous nature of work of this sort when it is considered that it is 75 feet from the operator's position to the bottom of the cut, where the ore which is broken is mucked into the cars and hoisted on an incline to the surface. A low grade copper ore, averaging about 4 per cent. copper, is mined at this location, the vein matter averaging about 125 feet in width at the place where the photographs were taken.

Great speed is made in drilling the rock. The jackhammer drilling about 6 feet every six minutes, operating with compressed air. Of course this record is very high, but the rock, an oxidized granite formation, is not hard. Three foot starters are used, followed with the six foot steels, the holes being drilled to take, $1\frac{1}{4}$ inch powder. A simple steel holder attached to the fronthead is found to be a material aid in withdrawing the steel from the hole. In addition, it enables the operator to lower and raise the steel in the hole, churning up the cuttings and preventing the steel from sticking or binding. The jackhammer is fitted with a special hole-cleaning device by means of which the operator can at will send a jet of air through the hollow steel to the bottom of the hole, thus keeping the drill hole clear of cuttings, dirt, etc., without removing the steel.

The writer witnessed an interesting performance of this jackhammer drill recently at the Bullwhacker Mine. Drilling was started about 8 o'clock one morning, using only one machine, and by 10 o'clock about 15 six-foot holes had been put in. After they had shot into this glory-hole it kept the muckers busy until noon of the following day getting the broken rock out of the way.

During the month of April of this year they broke enough ground at the Bullwhacker Mine with one jackhammer drill to enable them to ship sixty-four cars averaging about 50,000 pounds each to various smelters near Butte.

AERATING THE CATSKILL WATER

BY J. F. SPRINGER.

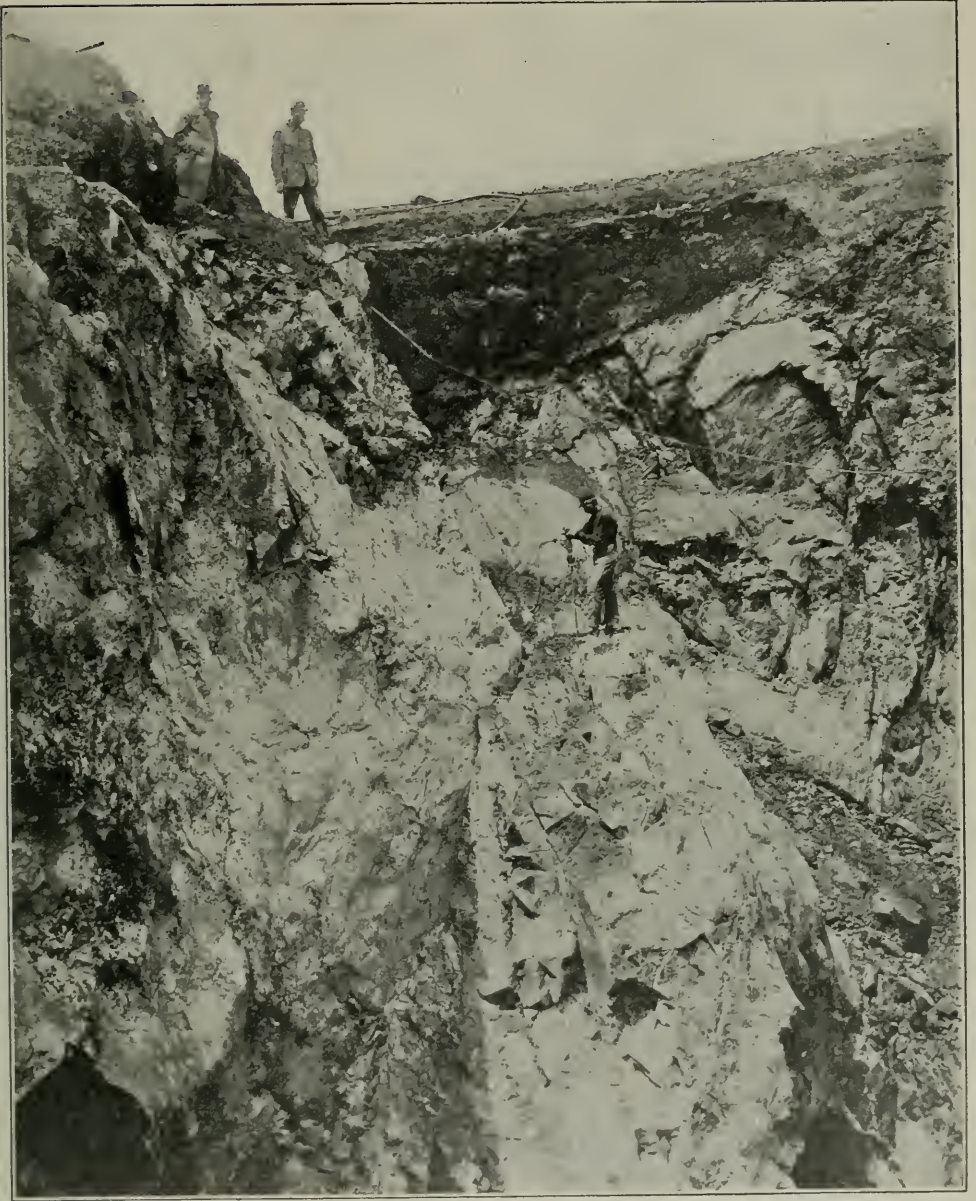
At Kensico Reservoir the aqueduct water is to be thoroughly aerated as it leaves for its final passage to the city. Aeration is a very simple matter. It consists essentially in exposing the water when minutely divided to the action of the free oxygen in the atmosphere. The oxygen costs nothing; so that

the chief expense is confined to managing and manipulating the water so as to bring about the desired division in the presence of the atmosphere.

The aerating apparatus will be located upon a by-pass connected with the effluent works of the Kensico Reservoir. Essentially, the aerator consists of a large number of nozzles fitted, for the most part, to risers projecting upward from a series of horizontal and mutually parallel pipes to which the water comes under pressure. These nozzles eject the water in such way as to form a fan-shaped jet. There is a distinct whirling movement. It is expected that the jets will rise to a height of about 15 feet. The normal head may be taken at 20 vertical feet. The entire group of jets, about 1,600 in number, will be arranged in a basin of concrete at a point accessible to sight-seers. The display should really be worth seeing. While the water is in the jet form it will be exposed to the action of the free oxygen in the atmosphere, and afterwards the oxygenating activity will continue because of the particles of air trapped and carried along.

The practical working out of this system has been the subject of study and experiment. The nozzle which will probably be used is in the form of a cylindrical shell fitted above with a short abruptly tapered tip in the form of a frustrum of a right cone, and below with a flange affording a suitable means of attachment to the risers. The nozzle is $7\frac{1}{2}$ inches in height over all. The internal diameter of the exit opening is $1\frac{3}{8}$ inches, the internal base diameter is $3\frac{3}{4}$ inches, enlarging to 4 inches. There are within three vanes, so formed and arranged as to impart a whirling or rifled movement to the column of water passing through. These vanes extend at the bottom in a radial direction from the shell to about $\frac{3}{8}$ inch of the center. They are formed of thin plates and are 4 inches long. They make a quarter turn. Vanes and shell have a common thickness of $\frac{1}{8}$ inch. The bolt holes in the $\frac{3}{8}$ -inch thick flange are arranged on a circle having a diameter of $7\frac{1}{2}$ inches. The material is bronze. They are accordingly quite expensive; but it was necessary to have in view the effects of corrosion on the concrete if a corrodible metal of any kind, such as iron or steel were employed.

It is expected that the 1,600 nozzles will be competent to aerate the entire capacity of the aqueduct when the flow line in the reservoir



A COMFORTABLE JACKHAMMER JOB IN A ROUGH SPOT.

is at its normal level. The basin of the aerator will be 460 feet long and have a maximum width of 240 feet. There is to be a concrete apron having a width of 20 or 25 feet which will surround the basin proper. Its function will be to return any water carried beyond the limits of the basin itself. The plan outline of the basin is that of "a rectangle to which semi-

circles have been added on the ends and on one long side." Water comes to the aerator through several concrete conduits.—*Cassiers*.

A seam of coal 12 feet thick has been found near Isabel, S. D. It is said to be only six feet from the surface.

DRIVING A TUNNEL WITH MACHINES ON TRIPODS

BY THEODORE V. K. SWIFT.*

A description of the methods used by Witherbee, Sherman & Co., Inc., Mineville, N. Y., in driving an 8x9-ft. haulage tunnel in exceptionally hard rock may be of interest to mining men who have similar work to do.

The character of ground drilled is a mixture of unusually hard granitic gneiss with hard magnetite. The granite is very difficult to drill but breaks fairly well, while the magnetite drills more easily but does not break so well. The ore in the tunnel varies from a few inches up to eight or 10 ft. in width but through the last 200 ft. the ratio of granite to magnetite is approximately 3:2. Two 10-hr. shifts are worked with an hour between each shift and an hour for dinner.

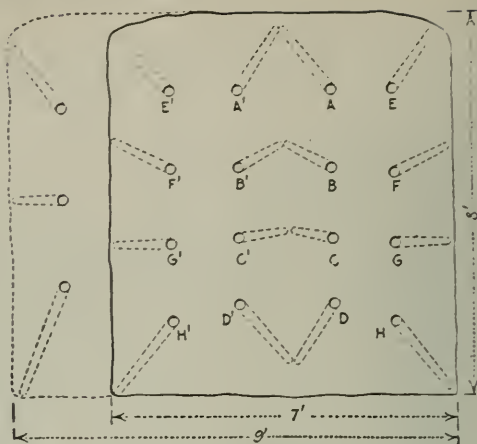
FACE DRILLED BY TWO MACHINES ON TRIPODS. A

THIRD MACHINE FOLLOWS AND SLABS OFF.

Two Ingersoll-Rand C-100, butterfly-valve, 2¾-in. machines, mounted on tripods of the Rand type, are used to drill the face and are operated by a drill runner and helper for each drill. The face is carried seven feet wide and eight feet high and a third machine is employed to follow up these two heading-machines and bring the tunnel to the proper width of nine feet. This machine is not run steadily. During one month it was capable of doing its work in an average of two shifts per week. This method is found to be quite advantageous over the method of carrying the face to the full width of nine feet as the tunnel advances, for this third or "trimming" machine can put in long side holes and break the ground more efficiently than if the holes are put alongside the other breast holes. This widening by the third machine is done on whichever side of the tunnel has the sharpest curvature, thus tending to ease the curves somewhat, as the tunnel follows the ore.

VERTICAL CUT USED IN THE HEADING.

Sixteen holes are needed to break the 7x8-ft. section. These holes average 4½ ft. in depth. Repeated efforts with deeper holes showed it to be impossible to break them to their full depth. The round is drilled approximately as indicated in the accompanying drawing, the dotted lines showing the work done by the



LAYOUT OF HOLES.

trimming machine, whose 8- or 10-ft. holes it is easy to bring because of the free side-face to break to. Much difficulty is experienced in drilling this hard rock and it often requires two or three starters and generally more than one second drill on each hard "upper." This round is drilled and fired once every 10-hr. shift and although the footage per drill may seem low, it is, nevertheless, a good shift's work, considering the unusual nature of the ground. Tripods are used simply because the nature of the work in other parts of the mine is not suitable for a column or bar and neither of these rigs is included in the mine equipment. One setup is generally sufficient to allow each machineman to drill his half of the round. A hitch is cut in the floor with a piece of hand steel for the point of the forward leg to rest in, a wooden block is buried in the muck as a foundation for the hind leg and the third or outside leg is thrown up against the side wall and does not rest in any hitch, thus leaving the whole rig free to be moved out of line, if necessary, when changing steel. Eight cut holes for the vertical cut are drilled and are bottomed as nearly as possible in pairs, A with A', B with B', etc. Outside of these, eight side holes are drilled to break even with the bottoms of the cut holes. Each machine is started on the top holes and lowered as the holes are drilled, one setup being sufficient for each machine with the necessary swinging of the machines in the saddles and adjustments of tripod legs. An air pressure of 60 to 70 lb. is maintained at the face.

*Mine captain, Witherbee, Sherman & Co., Inc., Mineville, N. Y.

FUSE BLASTING WITH DYNAMITE OF TWO STRENGTHS.

Du Pont 60% Repauno gelatin dynamite is used in all cut holes and du Pont 45% Repauno gelatin dynamite is used in side holes which are not too heavy, all sticks being spit and thoroughly tamped as they are put in the hole. All holes are fired with du Pont No. 6 blasting caps and du Pont double tape white fuse. In all cases the primer is put in the hole next to the last, with one stick on top of it, and all holes are thoroughly tamped with fine wet ore in standard du Pont paper bags. Holes *A A'*, *B B'* and *C C'* are spit first and as nearly simultaneously as possible. *E E'*, *F F'* and *G G'* with fuses cut four inches longer are spit next and the lifters *D D'* and *H H'* with fuses four inches longer than the side holes are spit last in order to throw the muck back as far as possible from the face. It requires two men to light these holes properly. All powder is prepared and all holes are loaded and spit by the regular mine powder-monkey with the help of one of the machinemmen.

MUCKING COMPLETED IN ONE-HALF OF EACH SHIFT.

All mucking, tramming and track laying is done by three muckers who work half a shift only and are then moved to some other part of the mine. At the beginning of each shift these men are sent directly to the face and muck back sufficiently for the machines to be set up while the machinemmen are assembling their rigs, connecting hose, etc. Permanent 45-lb. rails in 30-ft. lengths are laid on 4-in. ties as the tunnel advances. Two sets of 15-ft. 45-lb. rails and one set of 5-ft. 45-lb. rails are used temporarily to keep the track as close to the face as possible. Koppel $2\frac{1}{2}$ -ton, 22-cu. ft. capacity cars are used and are trammed to a side track where an electric locomotive hauls them to the portal of the tunnel. Short-handled shovels and no muck-plates are used.

Detailed costs for the month of October, 1912, are given in the table. This is not phenomenally cheap or rapid driving but under the unusually disadvantageous conditions, especially the hard formations, it was considered satisfactory.

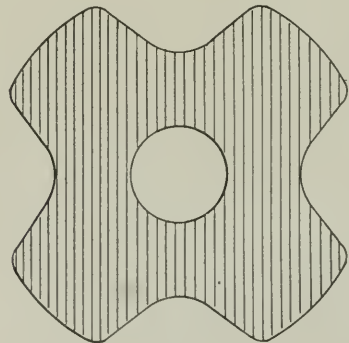
FORGING AND TEMPERING DRILL STEEL

The heat treatment of drill steel, hollow or solid, but particularly the hollow steel, is a special art. Only extended experience and careful attention to details will enable a blacksmith otherwise most capable to get the best results from steel of this type.

Properly treated, however, the life of hollow drill steel can be extended to extraordinary lengths, and breakages can be rendered almost negligible in the long run. It goes without saying that all steel must eventually break in the hard work of hammer drilling, but the careful blacksmith in co-operation with the watchful operator can get wonderful results where a fine quality of steel is used. Not every blacksmith or operator realizes this, and few have the time or the patience to experiment for the purpose of acquainting themselves with the individual properties of the special steels which may be in use at the mine.

As a help and a guide to blacksmiths handling drill steel, the International High Speed Steel Company has issued a special letter of instructions for the treatment of the "Bulldog Special" hollow and solid drill steel which this company manufactures.

The steel is made in Sweden, from the purest Swedish ores, and the instructions, which are reproduced below, come direct from the mill at Sandviken, Sweden, where elaborate experiments have been conducted to determine exactly at what temperatures and under what conditions of handling the best results can be obtained with "Bulldog Special" steel.



SECTION OF STANDARD CRUCIFORM STEEL.

The cut is a section of standard cruciform steel of this make, concerning which the following particulars are given out:

DETAILS OF STANDARD CRUCIFORM STEEL.

Outside Diameter	Diameter of Hole	Wt. per foot Solid	Wt. per foot Hollow
in.	in.	lb.	lb.
$\frac{3}{4}$	$\frac{1}{4}$	1.34	1.01
$\frac{7}{8}$	$\frac{1}{4}$	1.60	1.26
1	$\frac{5}{16}$	2.17	1.76
$1\frac{1}{8}$	$\frac{5}{16}$	2.73	2.22
$1\frac{1}{4}$	$\frac{3}{8}$	3.35	2.83
$1\frac{3}{8}$	$\frac{7}{16}$	3.98	3.69
$1\frac{1}{2}$	$\frac{7}{16}$	4.70	4.51
$1\frac{3}{4}$	$\frac{1}{2}$	6.82	5.89
2	$\frac{1}{2}$	9.10	8.03

FOR THE TREATMENT OF "BULLDOG SPECIAL" DRILL STEEL.

Forging. The heating must be done very carefully. If the steel is heated too highly it will become coarse grained and brittle, and cannot be restored. The steel should not be heated to more than a *light yellow*, and at this heat it must be taken out of the fire and worked at once. This applies particularly to tools in which a considerable change in shape from that of the original bar is required, and at this heat the steel can be worked thoroughly. Where there is not much forging to be done less heat should be used. But it must be observed always that hammering must be continued until the steel takes on a *dull red or brown color*, so that the grain will be coarse and firm.

Hardening. The steel should be heated slowly and evenly, and only that part which is to be hardened should be heated, and then only to a *dull red*.

Harden in water at a temperature of 75 to 85 degrees Fahr. The cutting edge of the steel should be submerged to a depth of only about $\frac{3}{4}$ inch. The neck of the tool should be submerged to a depth of $1\frac{1}{4}$ inch. But where the neck is upset, the steel should be hardened to a point about an inch below the upset part. When the tool is thoroughly hardened it should be taken out of the water and rapidly cleaned and tempered.

Tempering. It is impossible to give absolute rules for tempering the cutting edge of a drill steel. Broadly speaking, the temper must be suited to the hardness of the rock, and a careful study of the power of resistance of the steel in working will soon indicate what tem-

per is most desirable. Bulldog Special will generally give the best results if tempered to a *dark yellow*, but this must not be taken as a definite rule.

After tempering the tool should be placed cutting edge or point down in a vessel holding a depth of from $\frac{1}{4}$ to $\frac{1}{2}$ in. of water, and the steel should be left there until entirely cooled.

Tempering the neck or collar. The neck or collar must be tempered—or drawn—considerably more than the cutting edge. The very end or tip of the steel should be the hardest, and the rest should be tempered down gradually until it runs into the unhardened body of the tool. The tip or hammer end should be hardened to a light gray, or, if possible, until the steel only shines in a perfectly dark room with a dull brown color.

The cooling may be done in water, as with the cutting edge, but in treating Bulldog Special it will be found that the best results are obtained by allowing the steel to cool off in the natural air. When the neck or collar is cooled off in water the utmost caution must be used, and the cooling must be done very slowly. If at all permissible let it cool off in the air at ordinary temperature.

These instructions are being circulated gratis by the International High Speed Steel Company in such form that they can be readily hung on the wall of the blacksmith shop, or wherever most easily accessible.

"SOME NOVEL USES OF COMPRESSED AIR"

An extensive and liberally illustrated article with the above title in a recent issue of the *Scientific American* enumerates a number of things none of which have really any novelty at the present time, at least to readers of COMPRESSED AIR MAGAZINE, but it is still well to call attention to them occasionally. The pneumatic hammer is given the first place as used for chipping, riveting, caulking, etc., and for the wide variety of work normally employing a hammer or sledge or a dead weight raised and dropped continuously, as in sand ramming in the foundry and in paving work. Then there is the rotating pneumatic drill or auger for metal and wood work. Bell ringers, sheep shearers, butcher's cleavers and cane cutters are spoken of, and last and most novel of all is the compressed air auto starter, gear shifter, etc.

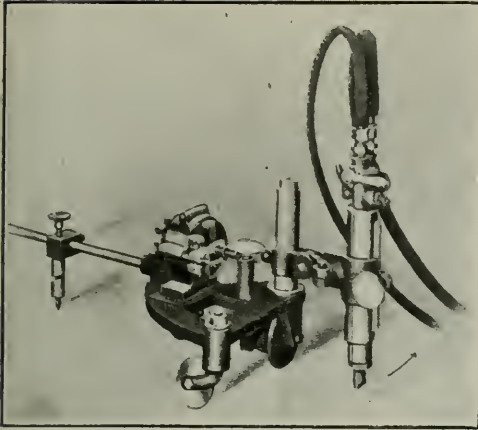


FIG. 1.
MECHANICALLY-GUIDED METAL-CUTTING
TORCHES

A recent addition to the line of apparatus developed by the Davis-Bournonville Co., 30 Church St., New York City, for mechanically guiding cutting apparatus, is shown in Figs. 1 and 2 of the accompanying illustrations. This new machine is known as the "radiagraph." It is a motor-driven device especially adapted to straight or circular cutting. The construction is very simple, the principal parts of the machine being a three-wheeled carriage for supporting the cutting torch, which is propelled along the surface of the work at the most efficient rate of speed by a small motor.

As will be seen by referring to Fig. 1, this motor connects with a vertical shaft through worm-gearing. At the lower end of this vertical shaft, there is a second set of worm-gearing which transmits motion to a horizontal shaft, which, in turn, drives the front tractor wheels through spur gearing. When it is desired to cut a circular opening, the conical center seen to the left is turned down into engagement with the surface of the work, which lifts the carriage slightly so that the weight is supported by the two outer wheels. The motor is started and the carriage then moves in a circle about the central pivot, and an opening is cut by the torch, the diameter of which depends, of course, upon the distance from the torch tip to the central pivot. The machine has a capacity for holes six inches in diameter and upwards. The driving motor is equipped with a small friction brake for regulating the speed in accordance with the thickness of the metal being cut. The rate of

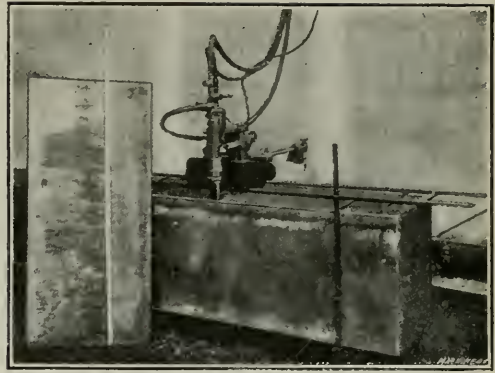


FIG. 2.

speed is shown by an indicator, not in place in this particular view.

Fig. 2 shows the application of the radiagraph to straight cutting, the work in this instance being a piece of armor plate 16 inches thick. The machine is caused to move in a straight line by mounting it upon parallel tracks having V-shaped grooves for the wheels. This track is notched at the ends so that two sections can be joined readily. For ordinary work one section is sufficient, but when taking long cuts, two sections are employed, thus making it possible to prolong the cut indefinitely by placing the rear section to the front as soon as the machine has passed it. The rate of traverse for cutting 16-inch armor plate is about four inches per minute and, as the illustration shows, the kerf left by the flame is remarkably smooth, considering the depth of the cut. For this particular work, the oxygen pressure was 125 pounds per

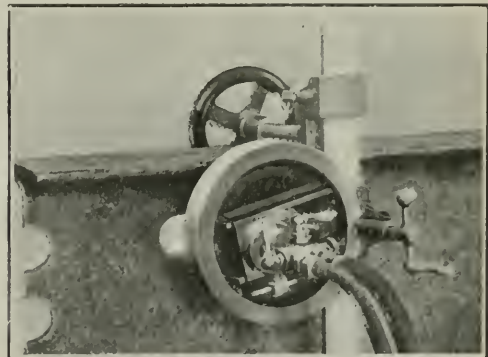


FIG. 3.

square inch. In case it is not convenient to connect the motor with a lighting circuit, small batteries can be used, so that the machine is adapted for yard use as well as in the factory.

Another recent development of the Davis-Bournonville Co. is shown in Fig. 3. This machine is known as a holograph and it was designed for cutting holes in the webs of rails or in structural material not more than $\frac{3}{4}$ inch thick. This machine has a circular member for holding the torch, which is rotated through bevel gearing by the handle seen to the right, thus causing the torch tip to move in a circle. The web of a rail can be pierced without any previous drilling and the machine will cut smooth round holes varying from $\frac{1}{2}$ to 2 inches in diameter, in from 30 to 60 seconds. The diameter of the hole cut, is varied by simply shifting the torch holder to or from the center of the rotating disk. The torch rotating mechanism is held in position by a vertical bar which, in turn, is clamped to the rail by the screw or handle shown. The holograph is especially adapted for railroad work and for enlarging or cutting holes in structural steel.

—*Machinery.*

MEASURING AIR CONSUMPTION.

BY ANDRE FROMIS.*

Since the introduction of compressed air in mining operations, many attempts have been made to produce a satisfactory means of measuring the actual air consumed by any given appliance. It is generally known that the builders of air machinery use a displacement tank to measure the air. This may solve the problem in the laboratory or the shop, but owing to the nature of the cumbersome equipment, such a device cannot well be moved from place to place, let alone to some restricted underground opening. Nor does the displacement tank register automatically a continuous line graph, depending for its position on time values and cubic feet as coordinates. Such a graph is unquestionably of greater value than the mere knowledge of actual air consumed. It permits of a time study that may point the way toward effecting material savings.

Present-day engineering efforts tend to

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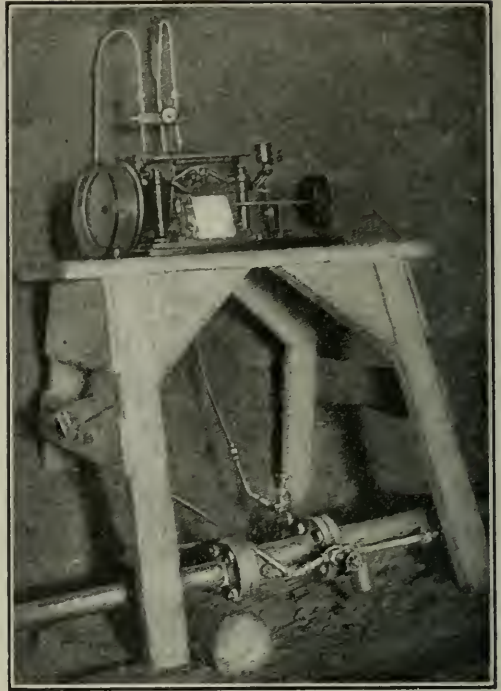


FIG. 1.

analyze in detail all the processes in the production of tonnage. The most important factor is the time-labor element. If then a certain appliance, such as a rock drill using compressed air shows a high time-efficiency, as compared to one showing low efficiency, it can be seen that even a considerable increase in air consumption will be largely outweighed by the additional work done with the high time-efficiency machine, always provided that the two machines have similar drilling characteristics.

This is well illustrated by comparing the old style, heavy, $3\frac{1}{8}$ -in. piston drill (quite indispensable in certain hard formations) and the jackhammer drill. The latter may actually drill at a lower speed, but a material gain is made by the absence of time loss in rigging up a post and in taking down and moving the drill on the post for new holes. One man operates the jackhammer drill, compensating for a smaller footage drilled.

In order to obtain satisfactory time-study values underground heretofore, sole dependence was had on observations made by an individual with watch and notebook. There

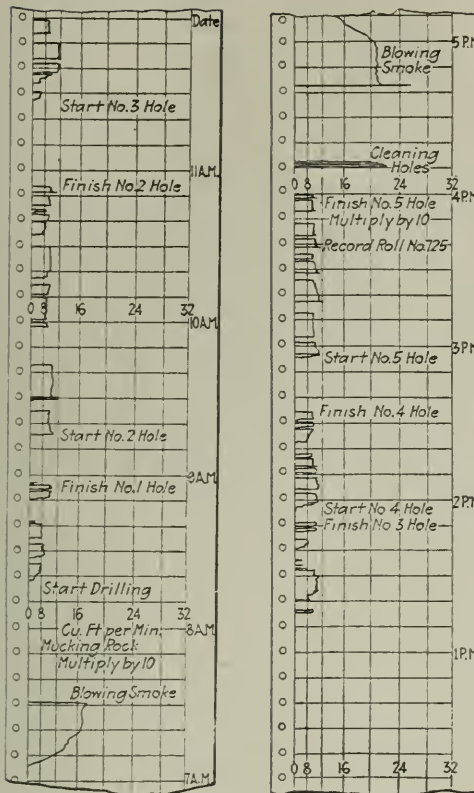


FIG. 2.

was always the question of quality and personal judgment, and furthermore the men operating the drill felt that they were under observation and the records thus made can hardly be classed as average performance.

AIR RECORDING METER NOW ON THE MARKET.

The General Electric Co. has lately put on the market an airflow meter, which measures the cubic feet of air consumed and records it graphically on a moving strip of paper. It can be seen that an observer's notes are accurately checked by such a meter, which is tireless and will run for a whole week without attention. A continuous record over a week of day-and night-shifts forms a basis for calculating a fair average shift's performance. One of these meters was installed at the property with which I am connected, and various air-consuming devices were measured. The most important were air drills, and time-studies were made in connection with these.

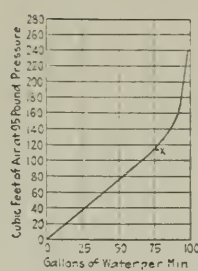


FIG. 3.



FIG. 4.

Fig. 1 shows a view of the meter with cover removed, connected to the air main on the 1900-ft. level, No. 2 shaft. One drill only was operating on this line on two 9-hr. shifts. A recording air-gage was also installed to ascertain the exact air pressure at any time near the drill. Fig. 2 is a copy of the record of the day shift Jan. 29, 1913, illustrating the cycle of work from one blasting to the next. The corresponding record of air pressure is shown in Fig. 4. The time study made in connection with the graph, Table I, illustrates the

TABLE I.

	b Day Shift, Jan. 29	c Average of Seven Consecutive Shifts
Total Time Consumed	Percentage of Total Time Consumed	Percentage of Total Time Consumed
Drill reciprocating	197	36.5
Changing steel	83	15.4
Shifting machine	95	17.5
Mucking for setup	55	10.7
Starting work morning and noon	22	4.1
Getting steel and water	12	2.2
Cleaning and charging	15	2.8
Blasting and tearing down	16	3.0
Blowing smoke	42	7.8
a 61.4% unavoidable.		
b 40 ft. 5 in. of medium hard Kearsarge amygdaloid drilled with one 31-in. piston machine. Cutting speed 0.205 ft. per min. Irregular rock bound steel.		
Flat holes in 7x10-ft. drift. Air pressure, 95 lb.		
c. Average number of holes drilled, 6. Average footage, 42.3.		

progress of the work. It will be seen that the time-consumption items may be divided into avoidable and unavoidable, the latter inherent in the operation. Such are the time that the drill is reciprocating, the time consumed in changing steel and that consumed in shifting the machine on the drill post. The remaining factors may be reduced or perhaps avoided if the additional footage drilled will pay for the additional labor required to do this work. Table II gives a distribution of the costs for the shift in question.

TABLE II.

	Amount per Shift	Cost per Foot Drilled
2 miners @ \$2.87	\$5.74	\$0.1420
Blacksmith @ \$2.75 and helper @ \$2.00	0.47	0.0116
Air, including labor, oils, etc., @ \$108.79 per month.	2.08	0.0518
Drill repairs @ \$0.40 per shift.	0.40	0.0099
Total	\$8.69	\$0.2153

DIFFICULTIES ENCOUNTERED WITH MINERS.

In stopping, conditions are somewhat different and more actual drill-reciprocating time should be obtained, but this may be pushed too far and it will be found that holes are drilled in excess of those required to break the tonnage. A larger amount of explosive will also be used. If in this case the men are re-proved or fined for drilling what may appear to be excess holes, especially if this footage forms a contract basis, there is always the question of judgment and for harmony's sake a board of arbitration may be advisable. There may also result some dissatisfaction among the men, making it hard to obtain good labor; finally the men may be led to neglect the trimming of the hanging wall, thus endangering the trammers on the levels.

It is thus apparent that a number of points must be considered at all times in order to equitably reduce the time-labor factor underground. It is also a fact that what may produce economical work in one property cannot be applied indiscriminately everywhere.

The study of these conditions is the logical field for the efficiency engineer, but he must be reasonably free from interference and be given enough authority to make his work possible and profitable.

The air meter was also used to investigate the air consumption of a small, single-stroke $7 \times 3\frac{1}{2} \times 7$ -in. plunger pump. The water was pumped a height of 250 ft. on an angle of 33° , the size of the suction and discharge lines being according to the manufacturers' specifications. The strokes per minute were counted and noted on the chart at the corresponding air-flow line. It was found that at 130 strokes, 85 cu. ft. were used. The horsepower drawn from the boilers to compress this amount of air was 13.1 hp., according to the manufacturer's catalog. The theoretical power required to pump the amount of water is 2.50 hp., without friction or leakage losses. The electrical power required, to pump this amount would be conservatively four boiler horsepower.

Fig. 3 has been plotted from a set of observations. It shows that the most economical speed is about 75 gal. per min., corresponding to the point marked X. This happens to be about three times the water to be handled per day; thus it determines the size of the sump,

and the number of attendants required to run a given number of pumps. Of course, the economical point is determined by such considerations as leakage in air valve, slippage in water end and water valves, moisture in compressed air inducing freezing, and size of suction and discharge pipes. This confirms the well known fact that pumping by air is uneconomical. At times electric pumping would entail considerable expense, but for permanent installations any reasonable additional cost will be repaid in a short time.

It may be stated that the air meter can be used on mains from 2 in. to almost any size. It is only necessary to install the nozzle plugs in the mains; the meter can be carried to that point, proper connections made with the nozzle-plug pipes, and a record roll of proper capacity placed on the meter drums.—*Engineering and Mining Journal*.

AIR INSTEAD OF STEAM FOR FIRE ALARM

At Haverhill, Mass., a powerful steam whistle has been in use as a general fire alarm for many years. It has, of course, been necessary to maintain the steam pressure at all times and the corporation has paid a manufacturing concern \$300 a year for the service. In place of this an air whistle is now being installed with an electric driven compressor. An air receiver is, of course, provided, which is kept charged up to the required pressure, and the starting of the whistle also starts the compressor so that the blowing may be maintained continuously as long as may be required and no power will be called for except while the whistle is actually blowing.

A HORRIBLE COMPRESSED AIR "ACCIDENT"

There are some dangers so obvious that it would seem to be absurd to warn people concerning them; and yet we are frequently reminded that "boys will be boys" without limit to the possibilities of their stupidity. In a factory at Camden, N. J., recently a "boy" 18 years old put a compressed air nozzle into his mouth and another "boy" turned on the air. The body was distended, the intestines were ruptured and death preceded by intense agony resulted in a few minutes. What can one say in a case like this to enforce the lesson it teaches?

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EVERYTHING PNEUMATIC

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ROCK DRILL EFFICIENCY RECORDS

On another page we print some account of the system followed by the New Jersey Zinc Company for securing by trial and inspection the most efficient and reliable drills for its service. It is proper to remark that the practice described is by no means exceptional with this company, but is practiced in fact by most of the larger concerns. The system in fact reaches much farther than to the selection of drills of the most efficient types, embracing also the maintenance of the efficiency of drills in use and the determining of the times when they must be completely overhauled or repaired, or perhaps more generally thrown out for good. The life of a rock drill which is crowded as it should be is not a long one at best, but while it lives the idea is to have a complete record of it based upon actual, systematic, periodic trial and examination, and the final abandonment of any drill is not based upon the judgment or caprice of any one but upon its proved and actual percentage of all around efficiency based upon the work it can do and the air it consumes in doing it. The practice indicated may not be paraded before the world as scientific management, but it represents business common sense, which is likely to hold its own for some time to come.

COMPRESSED AIR OPERATING CONDITIONS

In a paper read before the Liverpool Engineering Society, Mr. George J. Gibbs pointed out the importance of several conditions which govern the efficiency of equipments operated by compressed air. The air compressors should be supplied with cool, clean air which is as dry as possible. After compression, the heated air should be cooled before it is passed into the mains. Where this precaution is not taken, cooling in the mains will result in a deposit of water of condensation which will gradually collect and be driven forward with grit and rust until it finally causes trouble in the working parts of the apparatus. Compressed air can be conveyed through pipes for considerable distances with practically no loss, especially where the demand is intermittent and where a supplementary air reservoir is placed near the opposite end of the mains from the compressor. Although these are points which are generally mentioned, and which are constantly insisted

upon in COMPRESSED AIR MAGAZINE, their importance warrants the keeping of them before the users of compressed air equipment. In addition to the points above mentioned, two-stage compression is very important for delivery pressures above 40 to 50 lb. The common working pressure for a great variety of air operated tools and apparatus is now from 80 to 100 lb., with a constant tending toward the higher of these pressures.

AFTERCOOLERS AND SEPARATORS

The following from *Power*, July 1, will explain itself:

The note of E. R. Pearce on "Air-Receiver Explosions," in the Apr. 29 issue, in which he suggests that the air should pass through oil separators, represents good practice, as far as it goes. I would advocate the use of an aftercooler for the air to pass through first, and then a separator. Both of these devices may be said to cost nothing to operate, unless the small quantity of water passed through the aftercooler is to be charged. The installation cost may be regarded as a paying investment in practically every case. The aftercooler will somewhat reduce the volume of the air to be conveyed through the piping, and it will condense the surplus moisture in the air, so that it can be abstracted by the separator, as well as the oil. It will also keep the temperature of the air so low that spontaneous ignition in the receiver and piping will be practically impossible. Both aftercooler and separator are requisite for either of them to completely accomplish its work. The aftercooler will condense the moisture, but will not abstract much of it, and the separator will not abstract the moisture until it has been released by the cooling of the air. The functions of aftercooling and separating might be combined in a single device, but it does not seem to have been done.

It may be worth while to note that the too familiar air receiver and air pipe ignitions and explosions are impossible when the air is compressed by the Taylor hydraulic compressor, by the Humphrey pump, or a centrifugal or turbo-compressor, because none of these put any oil into the air. For ordinary working pressures, if two-stage compression is employed, with an aftercooler and separator, these precautions may be considered to

guarantee immunity. With a rapidly working single-stage compressor delivering the air at the same pressure, without aftercooler or separator, and with an engineer dispensing oil liberally, the guarantee would be reversed, and it would only be a question of time as to when something would happen.

FRANK RICHARDS.

NEW BOOKS

The Modern Gasoline Automobile, its Design, Construction, Maintenance and Repair, by Victor W. Page, New York, Norman W. Henley Publishing Company. 693 pages $5\frac{1}{4}$ by $8\frac{1}{2}$ inches, 500 specially made detailed illustrations and diagrams, \$2.50.

A complete, practical and up-to-date book, written in simple language, and, although so bulky, with few if any wasted words. The pneumatic interest which warrants our notice of the book is fully catered to in descriptions and discussions of tires, starters, etc.

Handbook of Natural Gas by Henry P. Westcott. Published by Metric Metal Works, Erie, Pa. XIV+529 pages, $4\frac{1}{2}$ x $7\frac{1}{2}$ inches. Price

In this book there is a table of pipe capacities which occupies 178 pages. There is another hundred pages of other tables and over fifty pages are occupied by illustrations. In the less than 200 pages of actual text there is assembled various information relating to natural gas, gas wells, gas transmission, easily accessible to one in touch with the industry.

The Catskill Water Supply of New York City. By Lazarus White, New York, John Wiley & Sons. 750 pages 6x9 in. Numerous illustrations. \$6.00.

This is the work of an able writer, a division engineer of the Board of Water Supply, who had free access to all records and data, and in the preparation of the work he had the assistance of many of his colleagues. It has all the reliability and completeness of an official report without its prolixity. The history of the work is given and accounts of the investigations which determined the location of the route in detail, and the local borings and other preliminary work upon which the contracts were based. The chapter headings suggest the scope of the work, and each chapter is concise and complete in itself. These are:

History of New York Water Works; The Board of Water Supply; Location of Catskill Aqueduct; Borings and Subsurface Investigations; Explorations for Hudson River Crossing; The Ashokan Dams and Reservoirs; Esopus Cut-and-Cover and Peak Tunnel; Rondout Pressure Tunnel and North Half Bontican Grade Tunnel; Wallkill Pressure Tunnel, North Cut-and-Cover, and One-half Bontican Tunnel; Wallkill Valley Cut-and-Cover Aqueduct; Moodna, Hudson, Breakneck, and Bull Hill Tunnels of the Hudson River Division; Peekskill Division Cut-and-Cover and Grade Tunnels; Steel Pipe Lines; Croton Division Cut-and-Cover Aqueduct and Grade Tunnels.

TESTING ROCK DRILLS

The New Jersey Zinc Company, at its Franklin Furnace mine, pays unusual attention to the efficiency of the drills employed. A series of tests begun by the company six or seven years ago, and still in progress, has resulted in greatly increasing the efficiency of the company's drilling and in bringing out some curious points in the performance of rock drills, intelligible in some cases, and in others largely inexplicable.

Every machine under consideration by the company is taken underground and its air consumption and drilling rate are measured, this being done in a certain crosscut where the rock is uniform. The number of perforations in the rock here bears eloquent testimony to the extent of these tests. The holes are drilled for the most part vertically in calcite, since here, as elsewhere, experience is relegating the piston machine to a secondary position. The rate of drilling is naturally high and the absolute figures would not be instructive to a hard-rock miner. The comparative figures, however, among different makes and types of machines, would prove most instructive if the company were willing to publish them.

The air pressure used is between 95 and 100 lb., and remains fairly constant for any one test. The temperature also is constant. The criterion on which the comparison of machines is made is a figure derived by dividing the number of inches drilled per minute by the air consumption per inch, thus taking into consideration both the speed and the air con-

sumption. No machine is accepted for further trial unless it drills at least $7\frac{1}{2}$ in. per min. on 60 cu.ft. of free air or less. A side light on the progress of drill design and manufacture is shown by the fact that for the machines of one manufacturer, the criterion mentioned has increased in some five years from about 0.2 to about 1.5, a remarkable difference.

This test is, so to speak, only an elimination trial. The results are comparable to an engine indicator-card, taken to determine mechanical efficiency. The important factors of convenience, repair expense, retention of original efficiency under wear, steel breakage, etc., are determined by further tests in the harder formation of the stopes. If a drill is purchased, its probation is not yet over. All machines in use are numbered and a careful record is kept of their performance during their whole life. They are, in effect, on the mine payroll, the number of shifts they work is credited to them and the repairs are charged. It would appear that after a few years of this, the New Jersey Zinc Co. should know something about machine drills.

One anomaly developed in the tests, is the fact that a machine will often drill along as well or better with one wing of the cross bit broken off. More curious still are the contradictory results obtained with the same machine under apparently identical conditions. Thus a hole may be collared and a test run made; then, with no further change than a new piece of steel, a second run continuing the same hole may give a rate of drilling much higher. The calcite is too uniform to permit explaining this by a change in the rock quality. Mr. Catlin, however, suggests a very plausible theory. He conceives the blow of the hammer and anvil block on the steel to be transmitted through the latter as a wave. Such a wave will be reflected when the bit transmits it to the rock in the hole bottom and in its return may oppose or may coincide with the next blow of the hammer. When conditions are such that these rebounds reinforce the successive hammer blows, the maximum drilling effect is attained. If the rebound and new blow oppose each other exactly, then the drilling power is appreciably cut down. The usual conditions will be a varying degree of interference, giving varying results. An attempt to analyze and con-

trol the phenomenon, however, disclosed that too many variables existed, of which the chief are the length of the steel and its resiliency. That great variations of resiliency obtain, is shown by dropping the same steel ball on different pieces of steel and noting the number and height of the rebounds. The differences developed are extensive. Evidently in the field of rock drills, drill steel, rock and their inter-relations, there are more things than our philosophers have yet dreamed of.—From editorial in *Eng. and Min. Journal*.

COMPARATIVE STRENGTHS OF BLASTING EXPLOSIVES

The U. S. Bureau of Mines has made elaborate tests of mining explosives in common use to determine the potential energy, the disruptive effect and the propulsive effect, some of the results of the investigations appearing in Bulletin 48. The tabulated results are given herewith, together with the approximate composition of typical examples of the various explosives. The percentages figured are rated against the effect of 40% straight nitroglycerin dynamite taken at 100 per cent.

The figures are fairly consistent with general practice, and it is believed that the classification will serve as a useful guide for comparing the practical value of explosives. It is worthy of note that the potential energy of 40% strength ammonia dynamite and of 40% strength gelatin dynamite, that is, the theoretical maximum work that these explosives can accomplish, is higher than that of 40% straight nitroglycerin dynamite, but that the disruptive and propulsive effects, which represent the useful work done as shown by actual tests, are less. Accordingly, straight nitroglycerin dynamite is more economical for general use in blasting operations if the conditions and character of the work are such as to permit its use; nevertheless, the ammonia dynamite and the gelatin dynamite are more efficient and economical for certain kinds of work that require explosives having a large propulsive effect and a comparatively small disruptive effect. For example, in blasting soft rock, 40% straight nitroglycerin dynamite, which has a very high percussive force, may be too quick in action, whereas the ammonia dynamite or the gelatin dynamite, having practically the same heaving and

TYPICAL ANALYSES AND STRENGTHS OF COMMON BLASTING EXPLOSIVES

	Percentage Composition					Percentage Strength			
	Nitro-glycerin	Combustible Material	NaNO ₃	ZnO CaCO ₃ MgCO ₃	Nitro-substitution Compounds	NH ₄ NO ₃	Nitro-cellulose	S C	Potential Energy Disruptive Effect Propulsive Effect
Straight nitroglycerin dynamite, 30%	30	a17	52	1	..	..	..	..	96.8
Straight nitroglycerin dynamite, 40%	40	b15	44	1	..	..	..	..	100.0
Straight nitroglycerin dynamite, 50%	50	b14	35	1	..	..	..	..	107.4
Straight nitroglycerin dynamite, 60%	60	b16	23	1	..	..	..	..	114.9
Straight nitroglycerin dynamite, 40%	30	b15	44	1	10	..	..	..	91.2
Low-freezing dynamite, 60%	45	b16	23	1	15	..	..	..	99.1
Ammonia dynamite, 40%	22	a15	42	1	..	20	..	..	95.8
Gelatin dynamite, 40%	33	a13	52	1	..	..	..	..	21.6
Granulated nitroglycerin powder, 5%	5	c35	60	..	..	..	1	11	58.6
Black blasting powder	..	..	73	..	..	..	..	16	..

a Wood pulp, flour and sulphur.

b Wood pulp only.

c Sulphur, coal and resin.

pushing action and less percussive force, will be more suitable. The tests also show that 60% strength low-freezing dynamite is not quite equivalent to the 40% straight nitroglycerin dynamite. It is worthy of note that black blasting powder has little disruptive effect, only about one-third that of granulated nitroglycerin powder.

BLASTING WITH LIQUID AIR

The first attempts to use liquid air as an explosive were made at an early stage of the liquid air industry. In fact, shortly after the invention of his process, Prof. von Linde (in 1897), by mixing liquid air with charcoal, succeeded in producing an explosive which he termed "oxylignite." This pulpy explosive was introduced directly into the blast hole and ignited by means of cartridges and fuses. As, however, this primitive process failed to give any satisfactory results, the explosive mass was filled into carefully prepared paper cylinders (preferably immersed entirely into liquid air), which were then introduced into the blast hole. Though sufficient explosive effects were thus obtained in most cases, this process did not warrant anything like real safety and depended in an extraordinary degree on the skill of the men and the rapidity of working.

These unsatisfactory results are due on one hand to the physical properties of liquid air itself and on the other to the imperfect process used in preparing the explosives. Liquid air at ordinary atmospheric pressure, i. e., in the open air, of course possesses a temperature of -191 deg. Cent. (-311.8 deg. Fahr.) and liquid oxygen a temperature of -182 deg. Cent. (-295.6 deg. Fahr.), the temperature difference as compared with the surrounding rock thus being about 200 deg. Cent. (360 deg. Fahr.). It will thus be readily understood that a lively exchange of temperature by heat conduction and radiation should be set up between the explosive and its surroundings, the liquid air in the blast hole being vaporized most rapidly by the absorbed heat. In fact, the explosive cartridges used in connection with these early experiments were found to possess a maximum life of 10 minutes at the outside, their efficiency being considerably reduced even after a shorter life.

After being discontinued for many years, these experiments were recently taken up again by a German mining engineer, Mr.

Kowastch, who in conjunction with Mr. Bal-dus, of Charlottenburg, was allowed to work at the Royal Quarries of Rüdersdorf, near Berlin. In accordance with the above, Mr. Kowastch tried to prevent the liquid air in the blast hole from evaporating by any possibility beyond a given limit. He therefore conceived the idea of introducing the cartridge with the dry carbon holder separately into the blast hole without the liquid air, and afterward making any mining preparations (tamping the blast hole, etc.), waiting until the very last moment to add the liquid air and igniting the mixture immediately afterward. This process obviously allows the time of vaporization to be reduced to a minimum, thus saving much of the liquid air otherwise required, cheapening the process and warranting an incomparably higher safety.

A substantial pasteboard cylinder containing a perforated distribution tube and filled with an absolutely inert mixture of kieselguhr and oil, asphalt, soot, or paraffin, is introduced into the blast hole. Into the central distribution tube is introduced a thin supply tube (of paper) over which another paper tube for discharging any products of vaporization of the liquid air is slipped, after which the tamping can be safely proceeded with. Whenever several blast holes are to be fired simultaneously, the electrical conductors are properly connected with one another and with the igniting battery.

The liquid air is kept ready for each blast hole in a special small flask containing a weighed quantity. These flasks carry at their opening a flexible metal tube with conical point into which the central supply tube is fitted. All that is required for charging then is to lift the back end of the flask, when the liquid air, under the pressure of its own products of vaporization (like mineral water under the pressure of carbonic acid) rises through the metal tube into the supply tube and through this into the cartridge, entering there between the individual particles of the charge, ready at the very moment explosion is started by electric ignition, to combine with the components of the cartridge in an explosion of terrific violence. The completion of the charge is readily ascertained by the cessation of the fizzing noise under which part of the liquid air escapes from the blast hole as a white fume.

This process thus eliminates all the difficulties experienced in early attempts to use liquid air as an explosive. Being readily prepared by a cheap process at the place of consumption, in fact, in the very gallery where it is to be used, it does away with the lamentable accidents inseparable from the transport and storage of dynamite above or below ground. Furthermore, there is no possibility of the explosive's being stolen, e. g., for unlawful purposes, nor is the manufacture of the explosive itself connected with any danger, while the presence of considerable amounts of oxygen in the form of liquid air is a valuable addition to the salvage arrangements of the mine.

By using the cheap fuel available in coal mines, the operation of a liquefaction plant will be cheapened sufficiently for liquid air to compete successfully with the ordinary explosives.—*Scientific American*.

HAND DRILLING RECORDS

The following records of hand drilling are worth preserving for the purpose of comparison. It is much to be regretted that the diameters of holes drilled and generally the kind of rock are not given.

SINGLE HAND RECORDS.

These three records were all made at the Midwinter fair, San Francisco, 1894:

E. F. Durham, Grass Valley, Cal., 19 31-32 inches, in 10 minutes.

T. J. Ahearn, Grass Valley, Cal., 19 9-16 inches, in 10 minutes.

D. L. Jones, Denver, Col., 18 11-16 inches, in 10 minutes.

DOUBLE-HAND RECORDS.

Moore and Butler, Pony, Mont., July 4, 1898, 32 inches, in 10 minutes.

Page and Wainwright, Sonora, at Stent, Cal., Sept. 9, 1899, 37 15-16 inches, in 10 minutes.

Bradshaw and Freethy, Butte, at Spokane, Sept. 24, 1901, 55 inches, in 15 minutes.

Ross and McLeod, British Columbia, at Spokane, Sept. 24, 1901, 51 inches, in 15 minutes.

Page and Pickens, at Tonopah, July 4, 1912, 45 7-16 inches, in 15 minutes. (In Roklu granite, 66 blows per minute).

Lindquist and Dahlen, Victor, Col., at Tonopah, July 4, 1912, 41 7-16 inches, in 15 minutes.

Porter and Goddard, Oatman, Ariz., at Tonopah, July 4, 1912, 38-7-16 inches, in 15 minutes.

Stewart and Carmack, Leadville, at Quarto-centennial, Colorado Springs, August, 1901, 40 plus inches, in 15 minutes. (Drilled through block of Gunnison granite in 14 minutes 30 seconds).

Hupps and Lindquist, Ouray, Col., at Quarto-centennial, Colorado Springs, August, 1901, 43½ inches, in 15 minutes.

Chamberlain and Malloy, Leadville, at Quarter-centennial, Colorado Springs, August, 1901, 41¼ inches, in 15 minutes.

McNichols and Lamb, Victor, Col., at Quarto-centennial, Colorado Springs, August, 1901, 41½ inches, in 15 minutes. (Previous local record said to be 39½ inches).

Names not given at Calumet, Mich., Aug. 24, 1912, 49 inches, in 15 minutes.

THREE HAND RECORDS.

Page, Kitto and Dingle, Grass Valley, Cal., at Jubilee fair, San Francisco, Feb. 22, 1898, 41½ inches, in 15 minutes.

Feeney brothers and Larkin, Grass Valley, at Jubilee fair, San Francisco, 36¾ inches, in 15 minutes.

Page, Kitto and Harvey, Amador, at Midwinter fair, San Francisco, 1894, 42 inches, in 15 minutes. (Forty inches through a block and two inches in a fresh hole).

Feeney brothers and Lynch, at Midwinter fair, San Francisco, 1894, 39 inches, in 15 minutes.

Amalgamated team, Butte, at Hancock, Mich., July 4, 1911, 59 inches, in 15 minutes.

Amalgamated team, Butte, at Calumet, Mich., Aug. 4, 1911, 59½ inches, in 15 minutes.

NOTES

In the treatment of pitchblend by the Austrian Radium Institute, it takes 10 tons of ore to yield approximately 1 gram of radium bromide. To obtain this there are 5½ tons of chemicals and 55 tons of water used, and there are over a thousand crystallizations made, each requiring from a few hours to several days.

New York City will soon have under simultaneous construction new subway and elevated lines for the Dual System of rapid transit to cost upwards of \$81,000,000. This work covers about 27 miles of new railroad, with

nearly 100 miles of track, as almost all the work is 4 track line. About 21 miles will be subway and 6 miles elevated. The work will be done by 14 contracting firms employing over 6000 men.

It is proposed to hold at Earls Court, London, from March 24 to April 4, 1914, an International Oil Industries Exhibition, which it is stated is receiving the support of the Governments of most oil producing countries. The exhibits will comprise oil-field equipment, transport facilities, refining plant, fuel systems and appliances, engines for power, etc., lighting and heating apparatus, etc.

In order to protect the valuable records of the Government from danger by fire Congress has made an appropriation for the installation of a modern system of auxiliary fire protection for three of the largest buildings occupied by the Department of the Interior in the city of Washington. A committee has been appointed to investigate the relative merits of systems adaptable to the buildings of the Department and to prepare plans and specifications. All communications regarding the subject should be addressed to the Chief Clerk of the Interior Department, Washington, D. C.

During 1912 a standpipe at the pumping station of the Harrisburg, Pa., waterworks, which had been used for equalizing pressure and was in need of repair, was modified in an unusual way, and made to serve as an air pressure chamber for the pumping engines. A manhole was put in the standpipe and a steel head or diaphragm was riveted in several feet above the bottom. The bottom of the standpipe was then connected with the discharge pipes of the two old pumping engines and the air pressure served the same purpose of maintaining the water pressure which had previously been done by the height of the water in the standpipe.

The use of liquid air to attain high temperatures in metallurgical work is commented upon favorably in a recent issue of *Echo des Mines*. At Ougrée-Maripaye a Thomas furnace is said to be worked by injecting liquid oxygen under pressure, into the hearth, where

it raises the heat to 2000° C. The reactions take place quickly without any change in the *modus operandi* usual in the making of steel. Large quantities can be treated, as with coal or coke, in a much easier manner than can be done in an electric furnace. The fusion time is reduced one-half, and a furnace can double its output, although there is some trouble in maintaining the furnace walls with such high temperatures.

An under-tired truck will cause only trouble and expense. Tire makers are ready to furnish eight by thirty-eight inch pneumatic tires which carry a normal air pressure of 160 pounds per square inch. A tire of this size will support a static load of 4000 pounds with a deflection of less than one-half inch, and is rated at 2000 to 2200 pounds capacity.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JUNE 3.

1,063,191. MACHINE FOR APPLYING CLOSURES TO BOTTLES. BERNARD GALLAGHER, Lynn, Mass.

1. A machine for applying closures to bottles, having, in combination, two members constituting a closure-applying head and a bottle support, and means for supporting said members and for moving one member toward the other to affix a closure to a bottle on the bottle support, said means including a pneumatic-pressure device operated by said movement, and means for adjusting the initial distance between said members to vary the pressure transmitted by the pneumatic-pressure device, substantially as described.

1,063,194. ENGINE FOR ROCK - DRILLS. GEORGE H. GILMAN, Claremont, N. H.

1,063,240. IMPACT-ENGINE. GEORGE R. BENNETT, Denver, Colo.

1,063,407. PNEUMATIC HORSE - COLLAR. FRED BATCHELER, Bomarton, Tex.

1,063,558. PREVENTING PULSATIONS IN CENTRIFUGAL AIR-COMPRESSORS. LOUIS C. LOEWENSTEIN, Lynn, Mass.

1,063,583. AIR-PURIFYING DEVICE FOR CREAMERY-VATS. FRANK R. NOONAN, Alexandria, Minn.

1,063,596. SELF-AUTOMATIC BLAST-GATE FOR CENTRIFUGAL COMPRESSORS. RICHARD H. RICE, Lynn, Mass.

1,063,624. TYPE-WRITING MACHINE. CHARLES H. VOGEL, Vancouver, British Columbia, Canada.

1. A typewriting machine having a carriage in combination with a pneumatic cylinder, a piston rod actuated thereby and attached to said carriage, a valve co-operating with said cylinder, means for normally holding said valve in a position to cause said piston rod to advance said carriage in the letter-feeding direction, a key for actuating said valve to cause said piston rod to move said carriage in the reverse direction, and means to return the key and valve whenever the key is released whereby the point at which the return movement of the carriage is arrested is under the control of the operator.

1,063,626. APPARATUS FOR MEASURING THE THRUST OR PULL ON SHAFTS. PAUL WAGNER, Charlottenburg, Germany.

1. In apparatus of the class described, the combination of two shafts arranged in substantially axial alinement and having the end of one adjacent to the end of the other, a member carried by the end of one shaft, a member carried by the end of the other shaft in sliding engagement with the first member, there being a pressure chamber between said members to which fluid under pressure can be supplied, and means for transmitting rotary motion from one member to the other without interfering with the relative axial movement of the members.

1,063,636. METHOD OF AND APPARATUS FOR FORCING OR COMPRESSING FLUIDS. ALFRED BARBEZAT, Paris, France.

1. The method of forcing or compressing a fluid which consists of heating a portion of the stream of fluid to decrease its density, accelerating the velocity of the cooler and denser por-

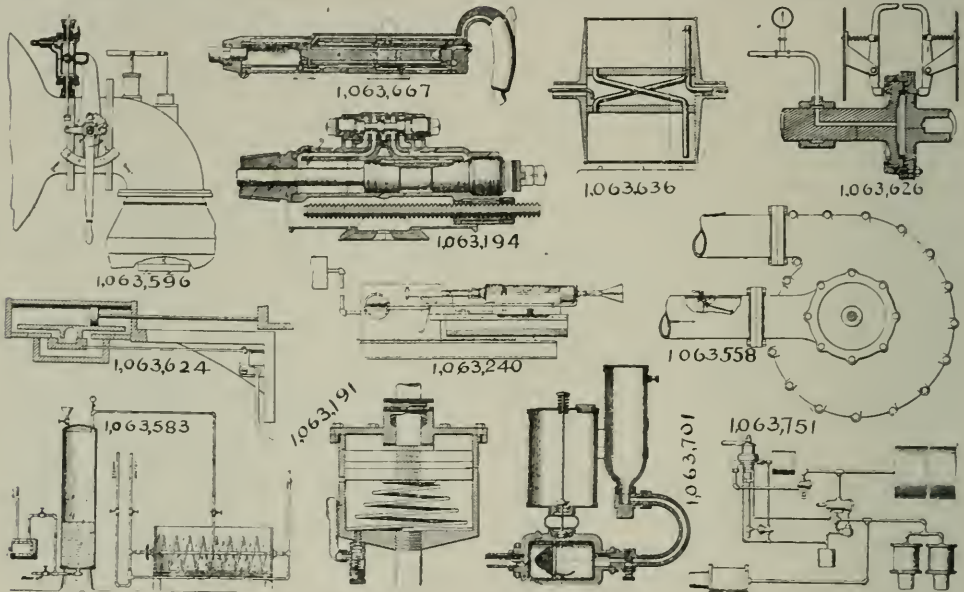
Baume by subjecting it to the action of ozone or ozonized air.

1,063,751. FLUID-PRESSURE BRAKE. WALTER V. TURNER, Wilkingsburg, Pa.

1,063,898. PNEUMATICALLY-CONTROLLED MUSIC-PLAYING DEVICE. PETER WELIN, Newcastle, Ind.

1,063,901. GAS-ENGINE STARTER. ELWOOD C. ALLISON, Brooklyn, N. Y.

1. A gas engine starter including a fuel reservoir, a measuring tank communicating therewith, and having an outlet port, a carburetor communicating with said outlet port and having a mixture outlet port and an air intake port on opposite sides of said measuring tank outlet port, a compressed air reservoir communicating with said air intake port, means for manually establishing communication between said measuring chamber and said carburetor, and other means for manually establishing communication between said air reservoir and said carburetor.



PNEUMATIC PATENTS JUNE 3.

JUNE 10.

tion of the stream by centrifugal action due to rotating said portion before it is heated, and causing this denser portion at relatively high velocity to act upon the less dense heated portion.

1,063,666. INTERNAL-COMBUSTION TOOL. OTHO C. DURYEA and MORRIS C. WHITE, Los Angeles, Cal.

1,063,667. HAMMERING IMPLEMENT. OTHO C. DURYEA and MORRIS C. WHITE, Chicago, Ill.

1. In a hammering implement, a tool-carrying casing, a piston therein, means for reciprocating the piston by fluid under pressure, including an expansion chamber in which the fluid operates against the piston from one direction, an explosion chamber in the casing into which said fluid is exhausted from the expansion chamber and compressed by the piston, and means for causing an explosion in said last mentioned chamber while the fluid is under compression.

1,063,708. PROCESS OF REFINING BROWN SUGAR. UNO LUNDGREN and GUILLAUME GIERLINO, Brussels, Belgium.

1. In the art of refining sugar, the process which consists in bleaching a cold solution of sugar of a density of substantially 20 degrees

1,063,946. APPARATUS FOR TESTING AIR OR OTHER GASES. MAX ARNDT, Aix-la-Chapelle, Germany.

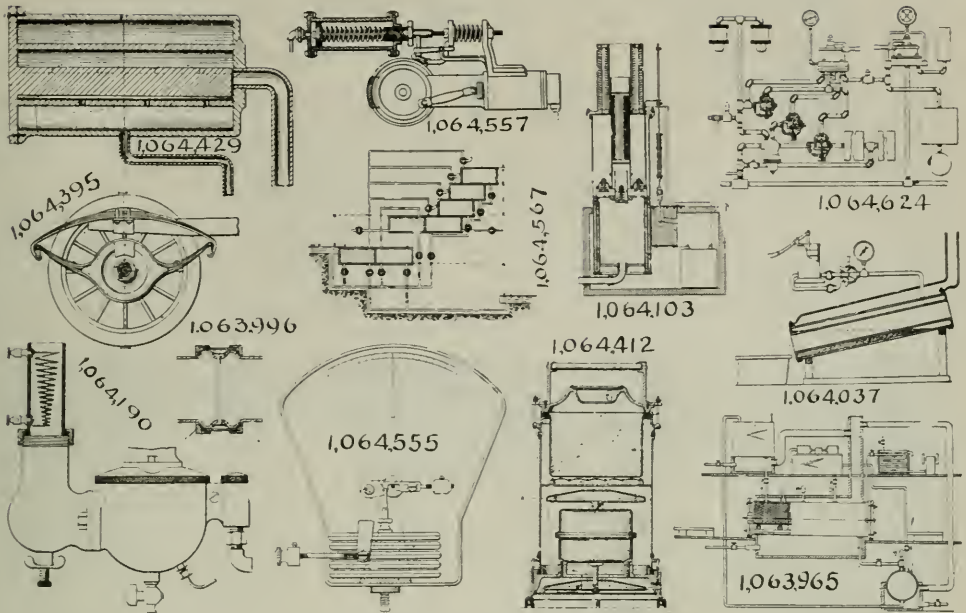
1,063,965. APPARATUS FOR TREATING PAVING-BLOCKS. CLAUD E. FULLER, Buffalo, Kans.

1. In an apparatus for treating paving blocks, an immersing chamber, a supply tank disposed higher than the chamber, a conductor connecting the tank and chamber, a drain receptacle disposed lower than the chamber, a conductor connecting the chamber and the said receptacle, an air compressor, a conductor connecting the compressor and the chamber, shut off valves located in said conductors respectively, a conductor connecting the compressor and the receptacle, and a conductor connecting the receptacle and the tank.

1,063,996. MECHANICAL JOINT FOR VACUUM-TUBES. DANIEL MCFARLAN MOORE, Newark, N. J.

1,064,037. MEANS FOR PROVIDING CONSTANT AND KNOWN HIGH TEMPERATURES. WILLIS R. WHITNEY, Schenectady, N. Y.

1. A heating device, consisting of the combination of a closed chamber, a vaporizable sub-



PNEUMATIC PATENTS JUNE 10.

stance therein, means for heating said substance, and a pump for establishing at any desired value the gaseous pressure in said chamber and thereby fixing at will the vaporizing point of said substance.

1,064,103. ELECTRIC AIR - COMPRESSOR. STEPHEN P. SMITH, Berkeley, and CHARLES W. KEIVER, Oakland, Cal.

1,064,190. ELECTRIC AIR-HEATER. LESTER A. BILL, Cambridge, Mass.

1,064,395. PNEUMATIC CUSHIONING DEVICE FOR VEHICLES. CHARLES L. SUTTON, Oakland, Iowa.

1,064,412. VACUUM - CLEANER. WALTER THOMAS WHITE, St. John, New Brunswick, Canada.

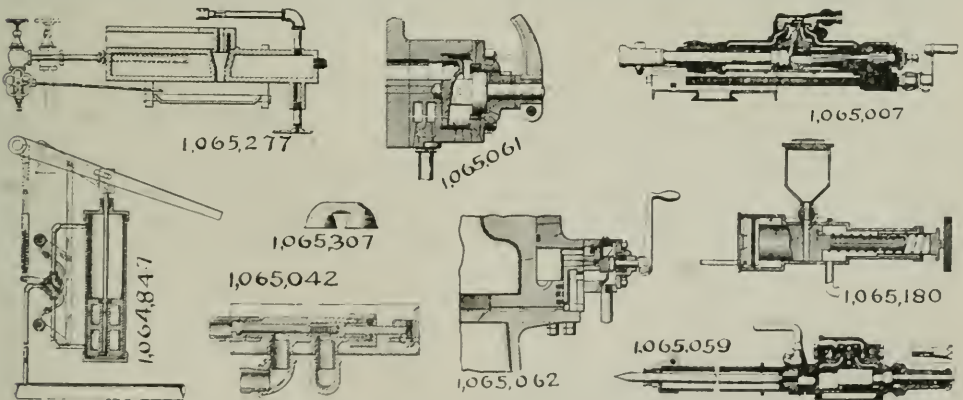
1,064,429. AIR AND OIL SEPARATOR FOR AIR-COMPRESSORS. AUGUST FRED BERGHAHN, Belleville, Ill.

1,064,555. VACUUM OR PRESSURE GAGE. JOHN F. SIMMANCE and JACQUES ABADY, London, England.

1,064,557. MEANS FOR PRODUCING AND CONTROLLING PNEUMATIC PRESSURE. HARRY SMITH, Harpers Ferry, Iowa.

1. The herein described mechanism for the purpose specified the same consisting of a cylinder, a piston arranged to operate therein, means for moving the piston in one direction, a spring for moving the piston in an opposite direction, a stop, a spring acting on the stop to hold it in a given position, a lock for holding the stop when moved by the said piston, and a trip connected with the piston for disengaging the lock from the stop.

1,064,567. PROCESS AND APPARATUS FOR AUTOMATICALLY RAISING WATER. GUSTAV TIEDTKE, Dortmund, Germany.



PNEUMATIC PATENTS JUNE 17.

1,064,624. AIR-BRAKE SYSTEM. FRANK H. DUKESMITH, Buffalo, N. Y.

JUNE 17.

1,064,783. PNEUMATIC CLEANING DEVICE. JAMES M. SPANGLER, Canton, Ohio.

1,064,847. PNEUMATIC ELEVATOR - DOOR CONTROLLER. EDWARD N. MILLS, San Francisco, Cal.

1,065,007. ROCK-DRILL. JAMES A. THOMPSON and EDWIN M. MACKIE, Chicago, Ill.

1,065,042. VALVE FOR AUTOMATIC HYDRAULIC AIR-COMPRESSOR-OPERATING SYSTEMS. ARTHUR GRANDJEAN, San Diego, Cal.

1,065,059. PNEUMATIC FEEDING DEVICE FOR STOPPING-DRILLS. JOHN GEORGE LEYNER, Denver, Colo.

1,065,061. MULTIPLE-FUNCTION CONTROLLED THROTTLE-VALVE. JOHN GEORGE LEYNER, Denver, Colo.

of said piston operating to close said cut off port.

1,065,347. STEAM - CONTROLLING APPARATUS. JOHN F. DEEMS, Burlington, Iowa.

1,065,375. PNEUMATIC TOOL. HENRY E. LE GENDRE, Cresskill, N. J., and GEORGE LEICH, New York, N. Y.

1,065,425. COMPRESSED-AIR MOTOR. IGNAC BASINSKI, Chicago, Ill.

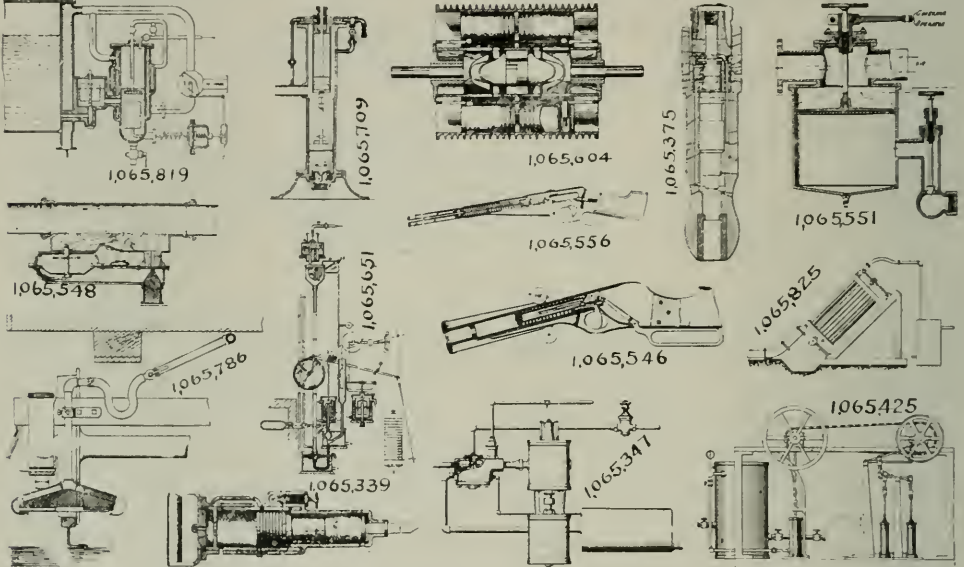
1,065,499. MACHINE FOR BLOWING GLASS BOTTLES, JARS, AND THE LIKE. ALBERT BEVERLEY, Gorrington Park, Mitcham, England.

1,065,546. PNEUMATIC GUN. JAMES A. PACKARD, Milwaukee, Wis.

1,065,548. AUTOMATIC CARRIER SEPARATOR AND DESPATCHER FOR PNEUMATIC - DESPATCH - TUBE APPARATUS. ALBERT W. PEARSALL, Lowell, Mass.

1,065,551. GAS AND AIR MIXER. JOHN D. RUSS, Spencer, W. Va.

1,065,556. MAGAZINE AIR-RIFLE. ELBERT HAMILTON SEARLE, Springfield, Mass.



PNEUMATIC PATENTS JUNE 24.

1,065,062. TRIPLE-PURPOSE VALVE FOR DRILL - BIT - SHARPENING MACHINES. JOHN GEORGE LEYNER, Denver, Colo.

1,065,180. GRAPHITE LUBRICATOR. LELAND D. SMITH, Louisville, Ky.

1,065,277. HYDROCARBON - OIL BURNER. GEORGE R. SHANKLIN, Portland, Oreg.

1,065,307. VACUUM STICKER OR ATTACHING DEVICE. JAMES P. EVERETTS, Sayre, Pa.

1. A vacuum sticker comprising spaced rubber vacuum cups arranged to engage a surface and be retained in position by vacuum, and a member connecting said cups comprising an elongated integral extension of said cups, and said member being relatively thin and yieldable, whereby the cups may be positioned out of alignment to engage different surfaces, substantially as and for the purpose described.

JUNE 24.

1,065,339. SINGLE-ACTING ENGINE. BENJAMIN BRAZELLE, St. Louis, Mo.

1. In a fluid-pressure engine, the combination with a cylinder having an air supply port, an air cut-off port, and an air outlet port, of a sleeve valve controlling said ports, and a solid piston sliding within said valve, the movement

1,065,604. FLUID-MOTOR. THOMAS J. GRAY, Chicago, Ill.

1,065,649. PNEUMATIC GOVERNOR. BURTON S. AIKMAN, Chicago, Ill.

1,065,651. AIR-PYROMETER. MAX ARNDT, Aix-la-Chapelle, Germany.

1,065,709. PUMP. PHILIP A. MYERS, Ashland, Ohio.

1. A pump comprising two cylinders of different diameters arranged longitudinally one within the other, the larger cylinder being formed with a water inlet and a water outlet, the inner cylinder having one end in open communication with the larger cylinder and having its other end closed and formed with air inlet and outlet passages, a single piston-rod operating in said cylinders, and pistons carried by said rod and operating in the respective cylinders whereby the piston in the larger cylinder will pump water, and the piston in the smaller cylinder will pump air on one side and water on the other side thereof.

1,065,786. RAILWAY SAFETY DEVICE. SAMUEL G. DAVIS, Horatio, Ark.

1,065,819. DEVICE FOR CARBURETING AIR. GASTON PAUL JEAN LION, Levallois-Perret, France.

1,065,825. ELASTIC - FLUID COMPRESSOR. GEORGE C. MCFARLANE, Denver, Colo.

COMPRESSED AIR

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EVERYTHING PNEUMATIC.

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FIG 1. NIGHT PHOTO OF PATTERN SHOP LIGHTED WITH HIGH PRESSURE GAS.

HIGH PRESSURE GAS LIGHTING IN BRITISH SHOPS*

BY I. W. CHUBB.

The high pressure system of gas lighting has been applied in Great Britain in many directions, not only for the ordinary public lighting, but also for large semi-public places, such as railway stations, and further in many industrial directions.

In the Keith system here spoken of the normal pressure is 80 in. of water, or say

3 lb. to the square inch. To meet the special requirements of some textile mills a pressure of 10 in. water gage is sometimes employed. The object is to insure at least a reasonable light should the pressure fail from any cause. In such a case gas from the mains at, say, 2 in. of water would still pass through the compressor (centrifugal), though of course the full light would only be given at the 10 in. pressure.

The compressed gas is admitted to inverted incandescent burners which, for the 10 in. pressure, are of one size only, 100 cp., taking 2 cu. ft. of gas per hour; thus giving 50 cp. per

*Condensed and rearranged from American Machinist.

cu. ft. per hour. On the 80 in. pressure the efficiency should be 60 cp., except in the case of the smaller lamps. Regarding upkeep, larger lamps require four or five mantles and one globe per year as an average.

The total amount of light supplied naturally varies according to the character of the work, and each case is considered on its own merits; but for average engineering shops the allowance is about 1 cp. per sq. ft. of floor space, a 1000 cp. lamp placed, say, 12 ft. high, covering 1000 sq. ft. This gives 3 ft. candles at about 3 ft. above the ground, but in some cases it is necessary to go much beyond this.

The lamps range from 60 cp. upward, and above 150 cp. the standard efficiency is 60 candles per cu. ft. Up to 1500 cp. units single mantles are fitted, but two and three-mantle lamps up to 4500 cp. units are available. For lathes and similar machines, over benches, etc., 60 cp. fittings, with copper spring antivibration pendants are usual. Generally, however, for machine lighting 100 and 150 cp. units, see Fig. 2, are employed, while for shops with overhead cranes, bigger units, 1000 cp. and 1500 cp. suspension lamps are employed, and they may be controlled by automatic distance lights, governed by bypass cock, plain lever cock or low pressure bypass.

The action of the lamp will be best understood from Fig. 3, which gives a section of the single-burner suspension type. The lamp is suspended, a tube at the top carrying the gas nipple and a dust trap. Gas under pressure passes down the venturi tube shown and by injector action takes in the required quantity of air, the mixture being delivered to a heater below. The high-pressure gas draws in a larger volume of air than is possible with low-pressure gas and consequently a highly aerated mixture passes down the tube. Adjustment of air is provided by a screw across the tube, the head projecting outside the casing. This, it is explained, acts as a throttle to the induced air, but the gas, being under pressure, is not affected. The throttle thus allows for variations of supply according to the quantity of the gas.

FLAME SMALLER IN HIGH-PRESSURE LIGHTING.

The size of the flame is smaller proportionately than with low-pressure gas, because the flame from gas already sufficiently aerated

does not have to seek for its proper supply of air. Therefore, the flame is more intense at its surface where it reaches the mantle. The latter is proportioned to fit the flame. Before passing to the burners, the gas mixture is heated, two shallow cones being fixed base to base with a diaphragm between. The latter is perforated toward the outer edge. The gas mixture impinges on this flat diaphragm and then passes through the holes, spreading over highly heated surfaces before passing to the nozzle. In the larger units, each lamp has a thermostat, a compound strip of brass and a low heat-expansion alloy being secured at one end to the heater, while the other end bears a disk which, when the strip is cold, almost covers an air inlet. An adjusting screw prevents entire closure. The resistance to air entry is automatically reduced with the warming of the lamp. This insures the lamp lighting quietly.

For lighting individual lamps at a height, flashing torches will give a blue flame 1 ft. long, methylated spirit contained in a reservoir being blown across a permanent flame by the action of pressing a rubber bulb. For controlling a string of lamps on the high pressure gas system an automatic lighter, shown in sections in Fig. 4, is employed. Here a silver diaphragm controls the passage of the gas. If the pressure is sufficient the diaphragm and spring-controlled plunger behind it are pressed back, the extent of the diaphragm movement being about 1-64 in. With reduction of pressure the diaphragm returns to its seating.

These automatic lighters are fitted to lamps placed, for instance, above cranes. As the high pressure gas is turned on, the silver diaphragm moves off its seat and allows the gas to reach the main burner, which is then ignited by the permanently burning pilot light, a flash occurring simultaneously.

A GOVERNOR CONTROLS THE LIGHT.

A governor controls the pilot light on the ordinary lamps so that its size remains the same whether pressure is on or not. By turning a lever the pilot is momentarily enlarged to insure the lighting of the main burner. The cock, Fig. 5, generally employed on suspension lamps, has a silver diaphragm controlling the bypass flame supply, the flame size being regulated by the screw on top. The

diaphragm is held slightly off its seat by a spring. On admission, gas passes by the port to the opposite side of the diaphragm, and then through the valve opening to the outlet for the bypass. The port being throttled somewhat by the screw, the tendency of the pressure difference is to close the gas outlet. This, however, would raise the lower pressure and thus, in conjunction with the spring, give the effect of balance, the difference of pressure between inlet and outlet being maintained whatever the actual supply pressure.

Thus for any given position of the regulating screw approximately the same quantity of gas will always pass. For the flash a small port shown in the plug communicates with a passage to the bypass when the cock is turned half-on, giving a further supply of gas to the bypass flame at the moment of turning on. If a bypass governor is required apart from the cock the form shown in Fig. 6 is employed.

HIGH PRESSURE GAS FOR OTHER SERVICE THAN LIGHTING.

High pressure gas is used also to a considerable extent in Great Britain for industrial purposes other than lighting, and the same means of compression are employed. Soldering irons have an internal bypass cock to control the heat, and removable solid copper bits held by a setscrew; and as the air supply can be controlled and set by a ring, high efficiency can be obtained with uniform heat. All classes

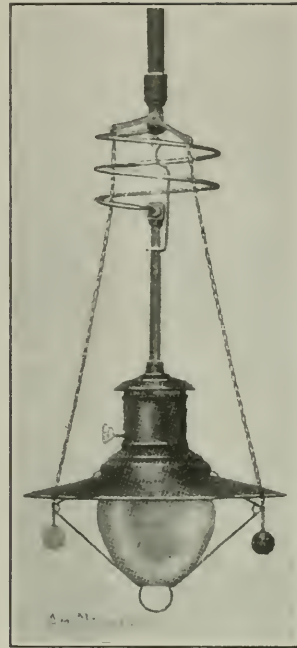
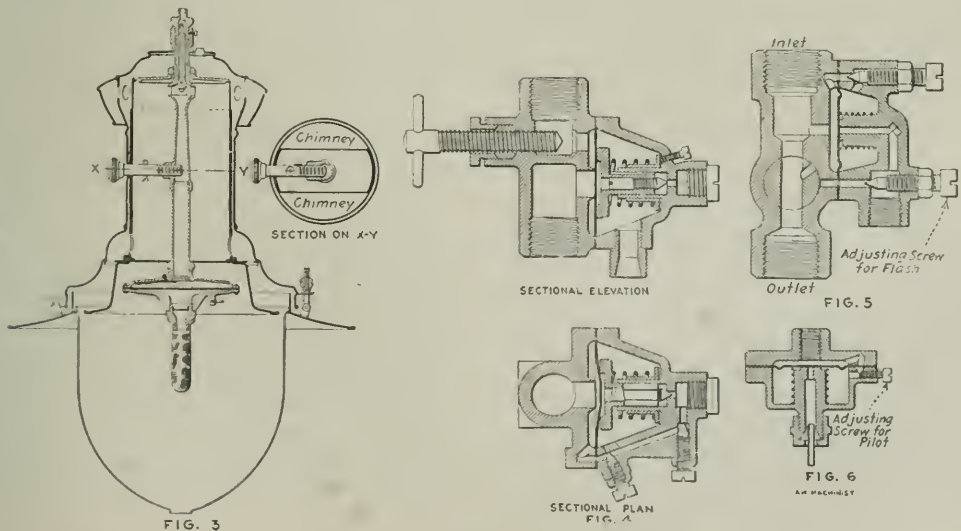


FIG. 2. HIGH PRESSURE GAS LAMP.

of gas-heated furnaces can be adapted for high-pressure gas, several in the works of the Keith & Blackman firm, for example, being employed for bending angle iron used for the frames of the ventilating fans also made by them. The ignited mixture of gas and air is



DETAILS OF LAMP AND CONNECTIONS.

passed downward on to the article to be heated.

THE HIGH PRESSURE SYSTEM APPROVED.

Inquiry among a number of engineering firms in Great Britain who are lighting their shops by this system developed that they are at least satisfied. An automobile firm in the London district is using 1000-cp. lamps, which, however, it rates somewhat lower. The average consumption of gas is about $16\frac{3}{4}$ cu. ft. At 2s. 5d. (58c.) per 1000 cu. ft. this represents less than $\frac{1}{2}$ d. (1c.) per nominal 1000 cp.-hr. Maintenance costs about 25s. (\$6) per 1000-cp. motor per annum. Another motorcar firm nearer the Midlands of England has had the system at work for some two years in its new works. The high-pressure gas system was installed after considerable trouble in inspecting installations, and after a consideration of the results obtained with the electric lighting in the older works of the same firm. This company reports that the system has proved fully up to expectation, both as regards cost of gas against current and cost of upkeep.

The main floor of this factory measures 130x125 ft. This is lighted by 20 lamps each of 1000 cp. No individual lamps are fitted, and it is found that with these comparatively large units a good general light is given, and that no extra lights are required at any of the machine tools or on the fitting benches. The shop has four bays, the lamps being hung centrally in them and staggered, and it is asserted that no cross-shadows are obtained, while the light at night is thought to be little inferior to ordinary daylight. In stores, drawing and other offices, similar lamps are installed, ranging from 60 cp. to 300 cp.

As the result of a number of tests, using gas at 2s. 3d. (54c.) per 1000 cu. ft. it is found that with all the lamps lighted the cost is just about 1s. (24c.) an hour. As to upkeep no record has been kept, this not being thought worth while. The light is found pleasant to work by, and it is asserted that 100 cp. in incandescent gas light is more effective than 100 cp. in electric light of any form previously tried, namely, incandescent, arc, or flame-arc lamps. One small difficulty has been overcome. It was found that some amount of oil from the compressor worked up the pipes and gradually clogged the nipples of the lamps, which, therefore, required cleaning. A trap

has, however, been fitted, and little or no trouble is being experienced.

A Glasgow firm of engineers specializing largely in centrifugal machinery has the shops lighted by lamps which vary from 300 to 1500 cp., the total amounting to 40,000 cp. The consumption is 727 cp. of gas an hour, giving an efficiency of 55 cp. per cu. ft. The price of gas being 1s. 11d. (46c.), the consumption per hour costs say 1s. 5d. (34c.). Driven by electric motors, two gas compressors are employed, each with a maximum capacity of 1000 cu. ft. an hour. These are run alternately, the cost for power and oil being at the rate of $2\frac{1}{4}$ d. (5c.) an hour. This firm considers that the lamps give a good light, but that attention is required to keep them and the gauzes clean. It is, therefore, important that they should be in such a position that they can be easily reached.

A gas stove and meter company has had a Keith-Blackman high-pressure lighting installation in use for about 18 months. The compressor is direct-driven by electric motor and the gas pressure is 54 in. The actual present lighting is more than 11,000 candles, distributed over 76 lamps, which range in candlepower from 60 to 300. The hourly gas consumption is about 552 cu. ft. and with gas costing 1s. 11d. (46c.) per 1000 cu. ft. this means rather more than 1s. (24c.) an hour. The average life of the mantles in constant use is two months, and the average cost of renewals for the lamps is about 3s. (72c.) a week. The cost of cleaning the lamps weekly for the complete installation is about 3s. (72c.), and in addition there is a small charge for current for driving the compressor, oil, etc.

EXPLOSION OF NATURAL GAS

The half-tone here reproduced from *Safety Engineering* shows what happened to a house in Cincinnati. The other side of the house was wrecked in the same style and also the rear of it. The house was piped with natural gas which was used for lighting, heating and cooking. The family retired early and the crash came about midnight. The oven of the kitchen gas range had been left lighted to take the chill off the rooms. Instead, the rooms were taken off, and fire insurance did not cover the loss. Perhaps as curious as any part of it was that no one of the five in family was hurt.



RESULT OF NATURAL GAS EXPLOSION.

HIGH PRESSURE GAS FOR CITY LIGHTING

Mr. F. V. Westermaier, the well known gas expert of Philadelphia, recently talked upon the above topic before the City Club of Chicago, some portions of his discourse being here reproduced.

The American traveler, he said, seeing for the first time at night the streets of Berlin, is amazed at the abundance of light in which they are bathed. Unconsciously he compares their illumination with that of the best lighted streets in America and concludes rashly that Berlin is extravagantly wasteful, but later he sees the wisdom of it.

Since the Franco-Prussian war Berlin has been practically rebuilt. Its development has been along lines to promote efficiency, civic beauty, public health and safety, and it stands to-day as the most modern of cities. The residential districts have been generally removed from the manufacturing and commercial centers and each has been planned to expand without crowding the others.

As the city grew in size the lighting of the streets increased in importance. The influence

of an abundance of light as a protection against crime was recognized, and in addition to this the ever increasing vehicular traffic, the cleaning of streets and the removal of refuse and garbage at night required adequate illumination.

Owing to the fact that on the regular low pressure gas units were limited to a maximum of 400 candle power, electric arc lamps of the flaming type seemed to have the advantage, but through the development of special lamps using gas at two pounds instead of two ounces pressure, the efficiency of incandescent gas lighting was increased three-fold; moreover, it was possible to produce units capable of giving from 500 to 4,500 candle power. Trial installations of these lamps were made, and as a result of several year's tests, high pressure gas lighting was decided upon for Berlin's principal streets, because it fulfilled all the requirements for quantity and quality of light, economy of operation and absolute reliability.

The adoption of high pressure gas lighting to replace existing low pressure gas units and electric lamps on the important thoroughfares

required the installation of special high pressure mains connecting the lamps with the compressor plants at the different gas works. For this purpose five inch Mannesman steel tubes were laid inside the curbs and driven under intersecting streets so that the paving would not be disturbed.

Direct connected gas engine driven compressors in duplicate raise the gas from $2\frac{1}{2}$ ounces to $2\frac{1}{2}$ pounds pressure and deliver it to the lamp system. The cost of compression is very low: the ratio of gas used in the engines to the gas compressed is as 1 is to 100. The pressure is automatically held constant and the compressor plants at the different gas works are so connected that one set or all can supply the lamps as a precautionary measure.

SATISFACTION—LARGER APPROPRIATION.

The municipality of Berlin was so well satisfied with the character of high pressure gas lighting, its flexibility, and fitness for the street system, that it appropriated the sum of seven million marks (\$1,660,000) for the extension of the system. The expenditure is made at the rate of one million marks a year to pay for main extensions and lamps, and the entire installation will be completed by 1915. In 1905 there were four miles of streets lighted by high pressure gas units; in 1911, 37 miles, and at the present time about sixty miles.

LARGE CITIES FOLLOW EXAMPLE.

Since the installation of high pressure gas lighting in Berlin, practically all the principal cities have made installations; the most notable being London and Paris.

In 1909 the City Council of London sent a committee to the principal cities on the continent for the purpose of investigating the most improved street lighting systems. On its return, this committee recommended that London should adopt high pressure gas lighting on all streets where a high degree of illumination was required. As a result, the city of Westminster within the past few years has replaced practically all its electric arc lamps with high pressure gas lamps of 1,500 to 4,500 candle power. Regent Street, Piccadilly, Pall Mall, Kingsway and other principal thoroughfares are now abundantly yet economically gas lighted.

Paris, long known as the "City of Light," has adopted high pressure gas lighting for its principal squares and some of its boulevards.

In time, lamps of 2,000 and 4,000 candle power will replace the low pressure gas lamps on all the important boulevards radiating from the Place de la Concorde.

Other cities throughout Europe are following the examples of the three important capitals and it is only a question of time before the general desire for better and more street lighting will invade this country.

As a modern illuminant, high pressure gas lighting will be one of the features of the Panama-Pacific Exposition. It is intended to use it extensively for the lighting of the main grounds and exclusively for the concessions. Also as a safe-guard against any possible failure of the electric supply, gas lamps will be distributed throughout the electrically lighted sections.

VOLUME, VELOCITY AND PRESSURE (DEPRESSION) METERS FOR GAS AND AIR

The annexed illustrations relate to the volume and velocity meter manufactured by Mr. Richard Cremer, York Place, Leeds, England, which has been designed for use in mines, steel-works, blast furnaces, gasworks, and, in fact, wherever measuring or registration of volume and velocity of large quantities of air and gas, traveling in pipes or channels, is to be carried out. It is, of course, an established fact that, considered independently, neither the draft pressure nor the volume, taken independently, can be regarded as reliable indication of the prevailing conditions in the fan drift or the main ventilating roads. If any reliance is to be placed on the records, both pressure and volume must be noted simultaneously. Normally, the static pressure will remain at the height corresponding with the area of the airways, and the volume of air supplied will, as far as possible, remain unchanged; both indications should therefore run fairly parallel so long as unexpected and unintended alterations in the ventilating system have not occurred.

If, for instance, a fall take place in one of the main ventilating roads, the static pressure will rise whilst the volume of air will be reduced. In the meter under notice, both these alterations are immediately recorded, one above the other, on the same chart. The appliance might also be usefully installed in up-cast shafts to indicate the "false" air ab-

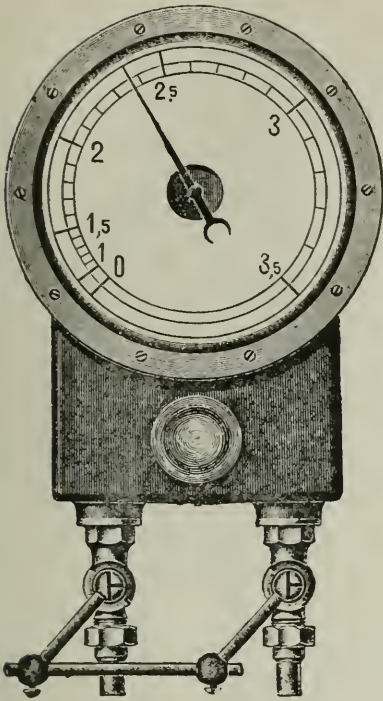


FIG 1.—VELOCITY AND VOLUME METER WITHOUT REGISTRATION

sorbed; thus, should the pressure fall with a constant or larger volume of air passing, it would be evident that too much "false" air was being sucked by the fan. The same would happen when, through any leaks in the airway, the amount of "false" air sucked increases. The meter then, with a larger volume, would indicate a smaller pressure.

The design of the apparatus permits it to be placed, within certain limits, at any distance from the place of measurement, and also allows the observation of various places by one apparatus by means of simply switching on or off the connecting pipes. The construction of the volume and velocity meter is shown in Fig. 3. As will be seen, a small baffle disc *s* is provided in the pipe *r* vertically to the direction of current. On each side of the disc close to its surface is a small tube conducting the pressure prevailing at the disc to the apparatus *a*. One of the tubes enters a float *g*, supported by a non-volatile oil in a cylinder *f*. The other tube enters the air-tight casing of the apparatus *a*. The float therefore acts under the difference of pressure prevailing on

both sides of the baffle disc, its movements being transmitted as shown to the pointer of the indicator, and to the chart *w* in the glass cylinder *c* by means of a writing pen *h*. The apparatus is provided with a scale directly showing the velocity in feet per second, or in any other desired unit of velocity.

The construction of the combined volume (velocity) and pressure meter is shown in Fig. 4. A baffle disc *s* and a horizontal disc

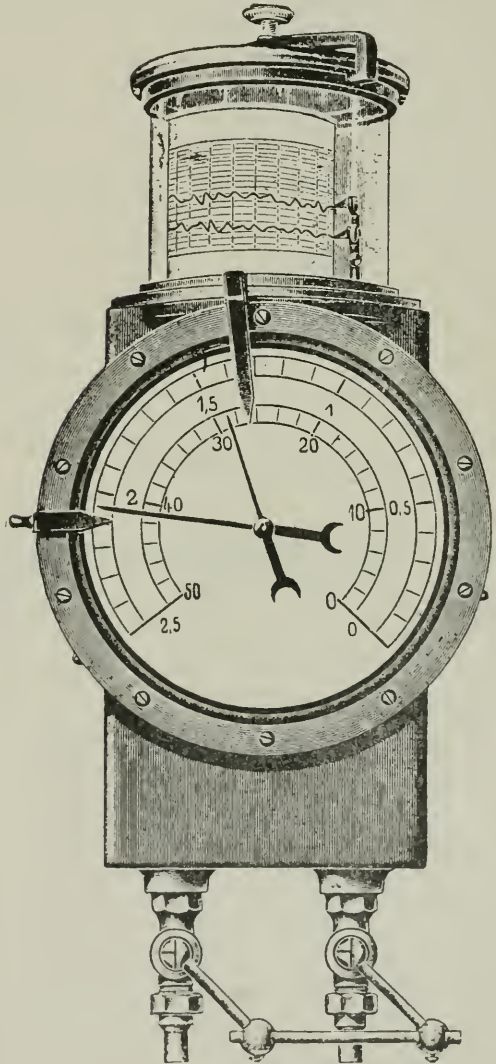


FIG. 2.—COMBINED VOLUME, VELOCITY, AND PRESSURE METER, WITH REGISTRATION ON 3-IN. DRUM.

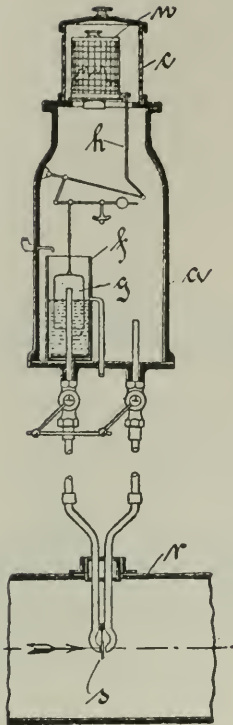


FIG. 3.

ss, are used in the measuring pipe in combination, the former being perpendicular to and the latter parallel with the air current. The velocity pressure acts upon the former, whilst the static pressure only influences the latter. Both discs are connected to the self-registering apparatus by twin pipes.

This apparatus contains in its air-tight casing *a* two floats *g* and *g*₁, working independently, to which the pressure acting on the discs is conveyed. The floats, which are supported in the vessels *f* and *f*₁ in non-volatile oil, transmit their movements to pointers or registration pens according to whether the apparatus is required with indicator or registration only or with both combined. The float chamber *g* is connected with the disc *s*, and the float chamber *g*₁ with the outer atmosphere, whilst the casing *a* communicates with the disc *s*₁. It will thus be noted that the static pressure prevailing in the pipe is reproduced in the casing *a*, whilst the pressure of the outer atmosphere is acting in the float *g*₁, and therefore the motion of the indicator will depend upon the pressure or depression in the

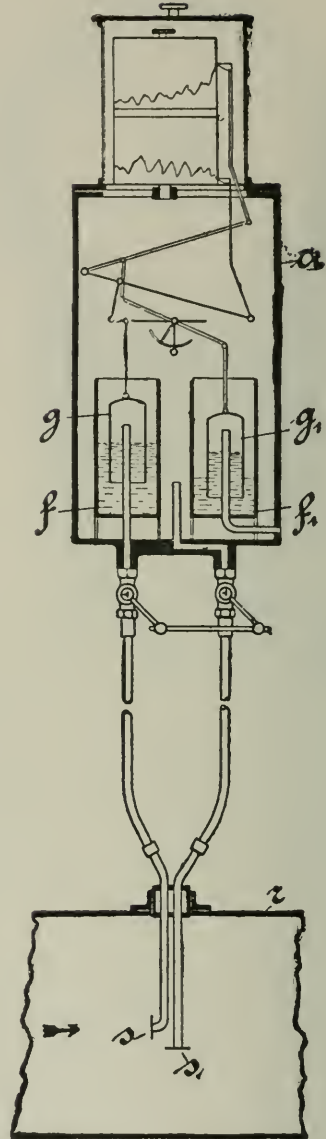
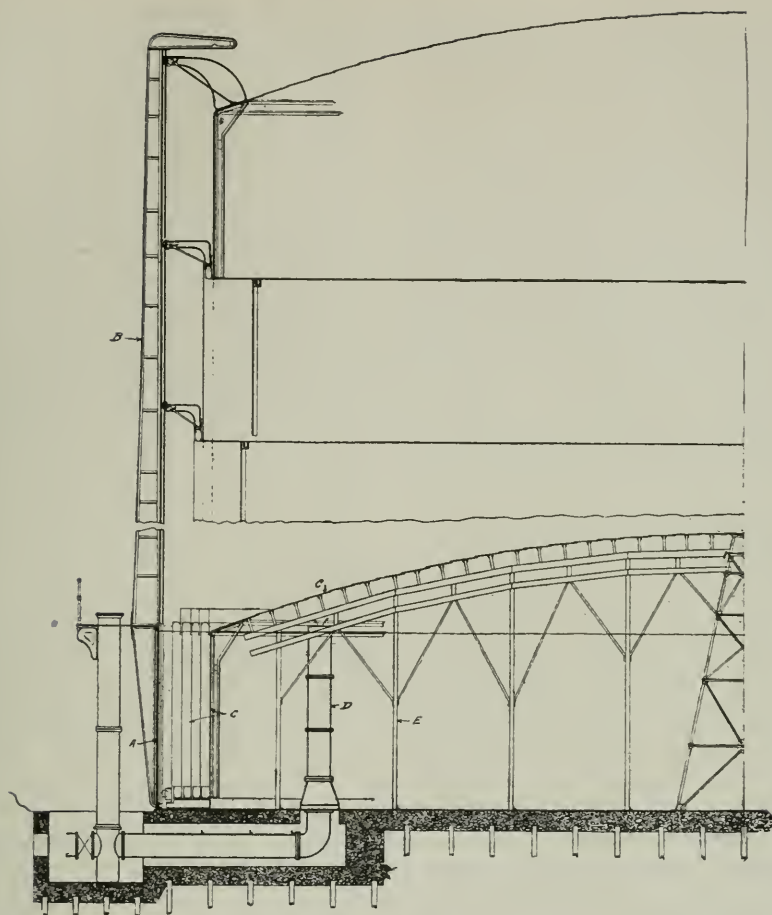


FIG. 4.

pipe. The float *g* is acted upon by both the static pressure and the velocity pressure. The action on it therefore consists of the difference between the static pressure and the static pressure and velocity pressure, i. e., the velocity pressure.—*Iron and Coal Trades Review*.

At Akron, Ohio, a graduate of Stevens Institute recently made a pleasure trip in a balloon inflated with natural gas.



SECTION OF TELESCOPING GAS HOLDER.

A NEW GAS HOLDER HEATING SYSTEM

A most unavoidably familiar object to all the dwellers in civilized communities is the gas holder. It is so big and towering that it forces itself, and generally not welcome, upon the sight of all. Few, however, whose attention has not been specifically directed to the matter, have any appreciation of the modern gas holder as a monumental achievement of engineering skill, which has involved the ingenious solution of a number of perplexing problems.

We here merely set out to call attention to the happy solution of one of the many details of gas holder design and management, but in the interest of the general reader it may be well to give a little sketchy account of the

arrangement and operation of the modern telescoping gas holder.

When gas was first introduced in London the capacity of each single gas holder was limited by law to 6000 cu. ft. on account of the supposed danger. When the assurance of safety was reached the capacity limit disappeared. The holder then became a large circular pit filled with water and a large inverted cylindrical vessel whose sides dipped into the water became the gas receptacle, rising or falling as the stored volume of gas increased or diminished.

With the introduction of the telescoping principle the capacities of the holders increased enormously and the excavation feature was abandoned, it being so much easier and cheaper to dig upward into the air than

downward into earth or rock. Holders with capacities up to 6,000,000 cu. ft. are now quite common, while there is one of 12,000,000 cu. ft. at Rotherhithe, England, and one of 15,000,000 cu. ft. at Astoria, Long Island, opposite New York City.

Fig. 1 is a half sectional elevation of a telescoping gas holder which will help to an understanding of its construction and operation. The holder is assumed to be empty with all the lifts down, their tops being at about the same level as that of the outer shell or water tank. *A*, is the water tank; *B*, the guide frame; *C*, the holder; *D*, the main pipe used either as an inlet or outlet; *E*, the wooden crown support which saves the top from collapsing when pressure is entirely removed.

The gas is forced into the holder through pipe *D*, filling the space between the crown and the surface of the water, means being provided at first for the escape of the air. When the gas pressure becomes sufficient the first section of the holder begins to rise, and when it has risen to its full height what is practically a hook all around its lower edge engages with a similar internal hook at the top of the next section and then the two sections rise together. The second section lifts the third in the same way, and that in turn the fourth if there are so many. The entire top of the first section, being exposed to the gas pressure within, is a lifting surface, and this area being so great it is evident that the possible gas pressure in the holder must be very light, it being greatest when the holder is full and all the telescoping sections are supported by the pressure under the upper one.

The entire upper section is of course gas-tight in itself, but it is quite necessary to continue this gas-tightness from section to section, so that there shall be no appreciable leakage. This is accomplished, where the sections meet, by the water seal, an ingenious but essentially simple device. The external hook spoken of at the lower edge of each section, being continuous all around the shell, forms in fact a deep annular cup, and when each section rises from the water tank the cup is necessarily filled with water, and the inner lip of the next section projecting down into this cup and being submerged in the water the gas cannot pass it and escape.

That is, the gas cannot escape as long as the lip of the suspended section is below the

surface of the water in the cup. The water, however, feels the gas pressure, being driven down on one side of the lip and rising correspondingly upon the other side, the difference in the height of the water upon the two sides adjusting itself with perfect accuracy according to the pressure, and at this point is determined the limit of pressure the holder can retain. The moment the water outside the submerged lip descends to the edge of the lip the gas will begin to escape at once, and that ends it. In the design of the holder the total weight of the lifts must be arranged in connection with the permissible submergence of the lip, so that the pressure required to lift the holder sections shall not be enough to drive the water quite down to the bottom of the lip, and as long as this does not occur the gas will not escape. The lower edge of the lower lift is a plain sheet, and when this is lifted out of the water the gas escapes and it is impossible for the holder to rise any higher.

As a matter of fact, the submerged internal lips spoken of do not come into actual contact with the bottoms of the cups, certain grips or lifters being provided to carry the weight, and water is free to flow as described from the outside to the inside of the submerged lip, or vice versa.

The gas holder is exposed not only to enormous wind pressures, which it must be braced to withstand, but also to changes of temperature, and this becomes serious when freezing begins, and has involved another difficult problem, as of course the freezing of the water seals must be prevented so that they may be perfectly free to act in releasing the sections when descending or in picking them up when ascending. It is also necessary to prevent the freezing of the water in the tank so that the holder sections may be free to move up and down. As long as only small holders composed of bell and tank were used, heating was a simple matter. Into the circular space between holder and bell, several steam ejectors were placed that absorbed the water, mixed it with steam, and gave it a circular motion, which prevented the formation of ice. When, however, the telescoped holders were used, this simple arrangement became impossible. To the holder heating is added the cup heating, which requires that the heating system should follow the upward and downward movements of the holder. Steam pipes, either rigid or flexible, must be used with

the use of roller guides and counterweights, and the result is much repairing and great maintenance costs due to the severe condition under which the heating system works. The quantity of steam used is considerable, for on the road from the lowest to the highest cup much heat is lost, so that it is never known whether enough steam is sent through the pipes. Another trouble lies in the fact that through the steam the cup water is always increased in quantity and the latter finally overflows and in severe weather freezes in large lumps on the outside of the holder. For a gas holder of say 200 ft. diameter and 160 ft. height another heating system would be desirable, and the Nürnberg gas works have used a new system for the last two winters.

The new system uses hot water instead of steam, the same working as follows: The hot water is mixed with the cup and holder water. Every cup is provided with a number of overflow pipes, which are conducted along the outside down to the next cup, and so down until the lowest pipes end at the surface of the tank. Now if hot water is forced into the upper cup by means of a pump, the water falls down from cup to cup, gradually losing its heat, till it reaches the tank. From there the overflow pipe takes the water back to the pump. The rigid mounted ascension pipe leads from the top of the tank to the highest position of the cup. From there a rubber hose, hanging free, communicates with the top cup. The hot water has to be conducted to the top cup, no matter what may be the position of the holder. The water flowing from the tank to the pump is heated by heating coils which are heated with steam. On the holder itself there are no apparatus that can go out of order. Since the heat losses in a hot water heating system are very low when compared to those in steam systems, the pump can stand at any distance from the holder—the distance in Vienna is 3,000 ft.—so that no special pumping room near the holder need be built.

The operation of such a system is very simple. One man is sufficient at the pump, who need not leave his post at all, as he need only read the temperature of the water returning from the holder to know whether to increase the temperature or not. If there is not enough heat, in other words if the heating coils are not doing the work properly, he can see the trouble at once by watching the thermometer

indicating the temperature of the water running to the cups. In a steam heating system he never knows whether enough steam is supplied, so that in this system the advantage lies in the greatest economy. If no steam is at disposal a hot water boiler can be used, directly fired. To judge the capacity, all that need be known is the number of heat units lost under severest conditions per hour in cups and tank; then the temperature and quantity of water can be determined without trouble. This system has been used during two winters in about six gas holders in various parts of Germany, one of these having a capacity of 250,000 cbm. (8,800,000 cu. ft.).

GASOLINE FROM NATURAL GAS

BY CHARLES T. HUTCHINSON.

It is doubtful when the idea of producing gasoline from natural gas originated. It has long been known that during cold weather a liquid collects in exposed pipes at many natural gas wells. At first the matter was regarded solely as a nuisance, since drip tanks had to be installed to separate the liquid from the gas, and when a considerable quantity of the liquid accumulated in the tanks they had to be emptied. That the liquid thus collected was gasoline was probably recognized by many persons, but for a period of several years there appears to have been no realization of the significance of the fact, and practically no attempt was made to utilize the product.

The pioneers in this development made arrangements with the lessees of a number of gas wells in the Pittsburgh district by which they were allowed to draw off the liquid from the drip tanks and dispose of it for a part of the profit realized. After going through a series of preliminary experiments it was found possible to prepare gasoline of excellent quality by simply compressing the natural gas in an ordinary air compressor and then passing the compressed gas through cooling coils connected to a suitable drip tank from which the separated gas could be drained off. Even with compression and cooling it is not possible to produce gasoline from natural gas which comes from the earth under high rock pressure, as such gas consists almost entirely of methane, and the natural pressure which exists in the earth has been sufficient to prevent its carrying any considerable amount of the heavier hydrocarbons.

Up to the last two years the general practice in the manufacture of liquid natural gas was to make the product by compression of the gas in single stage compressors operated at a pressure of 150 to 300 pounds per square inch. The one product thus obtained, so called "natural gasoline," was run into a tank and "weathered." The weathering consisted in allowing the lighter portions to volatilize spontaneously and escape into the open air, until such time as the boiling away of the liquid had practically ceased. The process thus involved a loss of 25 to 50 per cent. or more.

The next step in the industry was to pass the waste gases from the single stage compressor through one of higher stage, thereby getting a second and more volatile product which was run back into the first tank and mixed with the first or heavier condensate. This mixture was again weathered to a safe degree, whereby it lost the greater part of the more volatile product condensed in the second stage. Recently the process has been improved another step, in that the first stage compressor product is run into one tank and handled as ordinary gasoline; the second product into a separate tank and handled as a lighter gasoline with which the heavy refinery naphthas can be enriched or enlivened.

The natural gas of this country frequently contains light products that do not condense in the second stage compressor, and for which it is practicable and necessary to use three stage, four stage, and even more stage compressors. These light products—true gases at ordinary temperatures and pressures—can be compressed and liquefied, but the liquid gases so obtained must be handled as gases and not as oils. The mistake heretofore made in the "natural gas gasoline" industry, as some have recognized, has been the attempt to handle the light gaseous products as oils and not as gases.

Until the manufacturers of this lightest, or three or four stage, compressor product recognize its gaseous nature, the absolute necessity for insuring the safety of the public involves certain restrictions in its transportation, and not until the realization that this extremely volatile liquid should be handled only in strong steel containers, capable of withstanding high pressures, will it be transported with safety.

The vapors accompanying natural gas are clean and are ready for compression. They

are analogous to the manufactured products, but have the great advantage over the latter of being ready. However, they are at present in a great measure lost to the industries. The vapors should be compressed, as previously stated, but instead of being run into an open tank, or into a closed tank and weathered from it, with a corresponding loss, they should be run into steel containers and held there under compression. Such containers, capable of withstanding 3000 pounds pressure, may be procured from several firms. They may be transported to wherever gas of high heating or illuminating power is required.

One plant now in operation has a capacity of about 700,000 cubic feet of gas per day of 24 hours, and includes the following:

One two stage direct gas-engine-driven compressor, in which each stage operates independently of the other.

One intercooler, consisting of seven coils of 3 inch pipe with return bends, each coil 39 feet long.

One aftercooler, consisting of fourteen coils of 3 inch pipe, otherwise the same as the intercooler.

One small receiving tank which acts as a collector for the condensed gasoline.

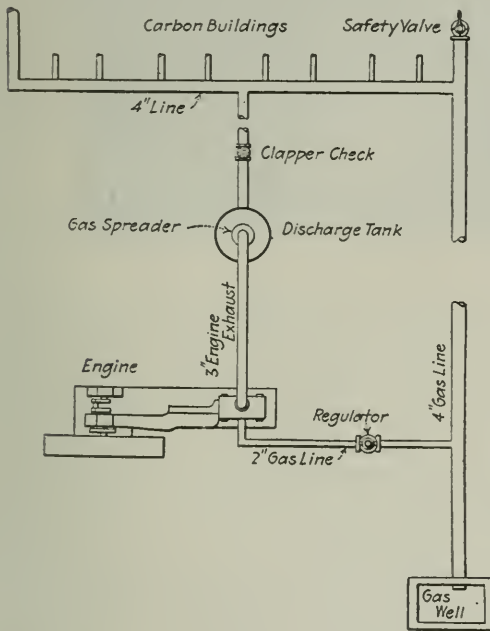
It will be noted that the high and the low pressure compressors are driven independently of each other. This is a desirable feature on account of the variable pressure at which gas is discharged from the well. Gas, after passing through a scrubber, is admitted to the low pressure compressor at or near atmospheric pressure, the temperature ranging between 60 and 65 degrees F. It is compressed to about 50 pounds, and a temperature of 190 degrees, at which it is discharged into the intercooler.

During its passage through the intercooler it is reduced to 45 pounds pressure and a temperature of 80 degrees, at which point it is taken into the high pressure cylinder and compressed to 250 pounds, the final temperature being 190 degrees. It then enters the aftercooler, in which the temperature is reduced to 60 degrees, the gasoline condensed being collected in the receiver and drawn off at intervals.

Both the intercooler and the aftercooler is arranged somewhat in the style of a cooling tower, and a spray of water is kept in circulation by means of a small pump, from the top of the cooler to a trough beneath, with baffles

arranged to give the maximum cooling effect.

An induction cooler is sometimes used for the final stage in the cooling process, before the gasoline is discharged into the receiver. This consists merely of a smaller pipe inside a larger one. A small amount of gas is permitted to expand inside the annular space between the larger and the smaller pipes, while the compressed gas, after passing through the aftercooler, is flowing through the smaller. The smaller pipe is generally two inches in diameter and the larger five inches.



NATURAL GAS DRIVES AN ENGINE.

INITIAL PRESSURE OF NATURAL GAS FOR POWER

The plant of the Union Gas & Carbon Company, manufacturer of carbon black, is located at Wilsonburg, W. Va. Their product is obtained from the flame of natural gas by allowing it to impinge upon a smooth surface and then removing the deposit by traveling steel scrapers. The carbon black is used extensively in the manufacture of printing ink, paints, etc.

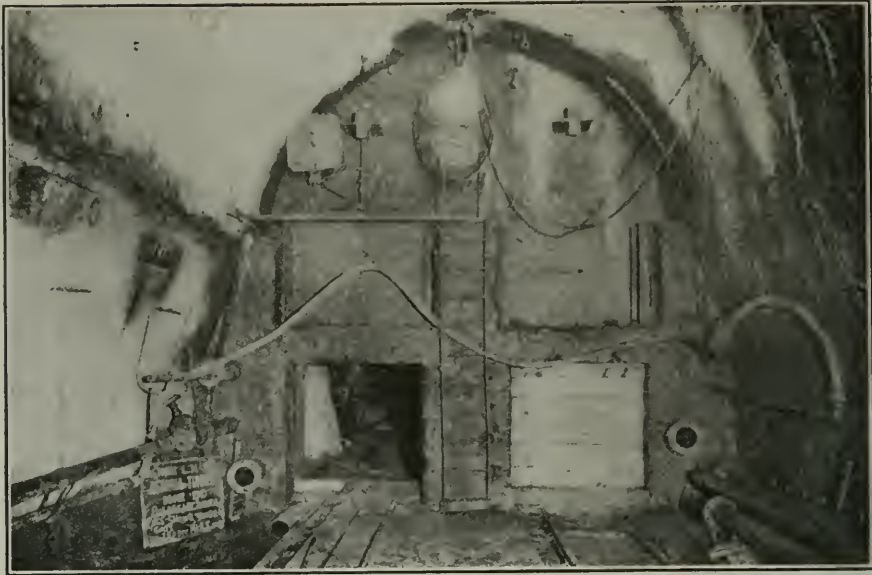
The natural gas emerges from a well 3,000 ft. deep at a pressure of 950 lb., which pressure was at first not utilized, the gas being led from the well through a 4 in. pipe direct to the burners, and the power required for the

scrapers and other machinery being supplied by a steam engine.

Later the steam boiler has been dispensed with and the gas has taken the place of steam in the engine, which besides developing the required power, thus serves also as a reducing valve. The sketch, here reproduced from *Power*, shows the piping arrangement. A 2 in. branch was taken off the 4 in. gas main and led through a regulating valve to the engine. The exhaust is led into a discharge tank, a spreader being provided at the end of the exhaust pipe. From the discharge tank the gas passes through a 3-in. main to a clapper check valve, which works simultaneously with each chug of the exhaust and allows the gas to feed into the carbon buildings with constant regularity. By using gas in place of steam in this manner, the engine is said to respond quicker and more uniformly. It also, not only provides free power, but reduces the labor by one man.

AIR HOSE

Armored hose is well intended, but it cannot be considered much of a success. In mine use it soon becomes badly distorted either by short kinking or by being crushed, and, though the fabric may be still intact, the air friction passing the strictures is soon excessive. A dent, once occurring, can hardly be straightened out again. Furthermore, to cut and patch the hose in such case, or if it be punctured, is a vexatious job, as the wire winding gives trouble. Better satisfaction has been found by the adoption of a hose similar to that used for air couplings on railroad trains, with a heavy fabric to stand the pressure and a thick protection of rubber on the outside. Such hose is not injured by short kinking nor is a stricture formed by rock falling on it, and should it be cut by a blast it can be quickly mended. A length of this was coupled to a length of armored hose and put in service in the South Mine open-cut, at Franklin Furnace, in February, 1908. It remained in continuous service until September, 1912, while the armored hose connected with it had to be renewed every few months. In fact it outwore so many lengths of the latter that count was lost. The material broken here was not particularly hard and sharp, and it is possible that in a quartzose mine the wear on rubber might be so excessive as to make armoring advisable.



SAFETY BULKHEAD IN ASTORIA GAS TUNNEL.

THE ASTORIA GAS TUNNEL

A large tunnel for the transmission of artificial gas from Astoria, Long Island, to the Borough of the Bronx, all within the limits of Greater New York, which tunnel has been under way for two or three years without much mention in the public prints, was "holed through" on July 17 and will soon be ready for service.

The tunnel has a D section, the flat side of the D forming the base of the tunnel. It is 19 ft. 9 in. wide, 21 ft. high and 4662 ft. long. It will at first carry two gas pipes 6 ft. dia., with ample room for two more as they may be required. The mean depth of the tunnel floor below the river surface is 246 ft., it being expected that at this depth solid rock would be found, and that the tunnel could be driven under constant exposure to the atmosphere, the depth was such that the pneumatic process of driving was not possible.

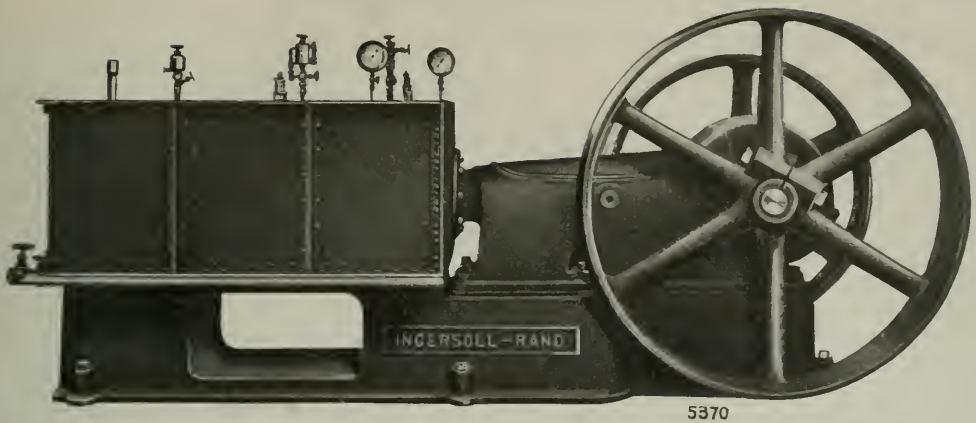
The tunnel was driven from two vertical shafts, the Astoria shaft being 34 ft. 6 in. in diameter and 277 ft. deep, while the Bronx shaft has a diameter of 26 ft. and a depth of 233 ft. The concrete lining of the tunnel varies in thickness from 18 in. to 36 in. and in some places is reinforced with steel rods.

After the headings had been turned the tunneling proceeded without difficulty for 750 ft.

from the New York side, when a large inflow of water was encountered and work at that end was suspended. The heading from Astoria was advanced 3500 ft., or to within about 400 ft. of the Bronx heading when the bad ground was again encountered. There were fissures of disintegrated material with water under full head, and in some places large pockets were uncovered.

Pilot holes had to be drilled in advance of the heading which were plugged with valved pipes and where the leakage was high these were grouted under great pressure. Concrete bulkheads also were built at intervals across the tunnel sections and were fitted with quick closing gates at the bottom and man locks at the top to prevent the flooding of the whole tube and to allow the workers to escape in case of a sudden inrush of water. Cast iron ring lining was used in this section. The 400 ft. of ground of this character took as much time and probably cost more than all the rest of the tunnel.

In putting in the concrete lining the ground water was drained away by pipes passing through the forms. These pipes are now being used to carry grout into the open spaces behind the lining and thereby cut off the leakage. Ingersol-Rand compressors and rock drills were employed for the work.



THREE STAGE COMPRESSOR FOR ACETYLENE.

COMPRESSION AND TRANSPORTATION OF ACETYLENE

BY R. H. CUNNINGHAM, JR.

Acetylene gas is to-day used very extensively for automobile headlights, and while the gas can be generated from the carbide just as it is burned, the operation is not without its troubles, and this has led the Prest-o-lite Company of Indianapolis to develop a commercial proposition whereby the autoist can be provided with portable tanks of acetylene gas.

It has taken years of practical experimenting and testing to prove all the queer characteristics of this gas, and the charging of the tanks has made a nice and delicate problem for the compressor people. At present a three stage compressor is used, charging the tanks at a pressure of 275 lb. Very slow speeds and the most reliable and effective intercooling and aftercooling are required as compared with ordinary air compressor practice. The heat of compression causes the gas to separate into its component elements which are ready to combine again at higher temperatures and cause a disastrous explosion.

The tank used for transportation is made of cold drawn steel. The tank is filled with bricks of asbestos, which material has a porosity of about 80%. An acetone, which has a great affinity for acetylene, is put into the tank and, due to this affinity, from fourteen to sixteen times as much gas can be put into the tank as it would hold without the acetone. The asbestos brick forms a sort of cell arrangement which allows the several

cells to discharge in succession rather than simultaneously.

The Ingersoll-Rand Company have built a special compressor for acetylene, and the machine has been carefully designed so that its work may be done most safely and efficiently, every emergency which can be anticipated having been provided for.

The three compressing cylinders are entirely submerged in a sheet iron water box, which also contains the pipes for intercooling between the successive stages. The piston rod gland is covered with water so as to reveal any leak of gas from the second stage of the compressor. The operator can detect any leak at a glance and can easily remove the iron box for purposes of repair or adjustment, so that one man can easily take care of a charging station.

The Prest-o-lite Company have several of these charging stations in the United States and Canada, having placed five compressors already this year, with five more to be installed before the spring rush of business.

This means of auto lighting, for lighting harbor or channel buoys, for acetylene welding and the like, has developed a wonderful business, and the distribution of these ready charged gas tanks throughout the country is now so well taken care of and the use and application is so simple that most people prefer to get a tank and apply it to whatever they may have to do with it.

The use of acetylene for auto lighting and auto starting grows constantly in spite of the present popularity of the electric starter and electric lighting devices, which have their good points but also their drawbacks.

PRODUCING GASOLINE FROM NATURAL GAS

BY FRANK P. PETERSON.

In 1911 the world's yield of crude petroleum is believed to have been about 320,696,316 bbl. While difficult to say just how this was split up into the various commercial forms, it is safe to say that not less than 10 per cent., or over 32,000,000 bbl., was used in the form of gasoline. This is notable in contrast to the fact that 20 years ago there was no appreciable demand for gasoline.

An important step in the production of gasoline has materialized during the past 2½ years in the form of stripping waste gases of suspended heavy hydrocarbon vapors and using these condensates as gasoline.

Theoretically, the process of recovery is very simple, namely, the application of pressure and cooling of the gas, provision being made for separating the condensates by precipitation under pressure.

Nearly all the oil wells yield some gas; many yield great volumes while others yield gas only from the strata in which the oil is produced. Again, some yield one gas from their oil strata and another gas from other strata through which the well passes and which is not "cased off."

The gases which issue from "dry" or non-oil-producing strata are often largely pure methane (marsh gas CH_4), which has a critical temperature of 115 degrees F., and will not condense at any pressure above that temperature.

The gases which reside in the strata along with the oil, however, are in contact with the oil in a finely divided state in the interstices of the sand. There is every opportunity for the methane gas, when issuing from the strata at low pressure along with the oil to pick up and carry in suspension any vaporous oil. Further than this, it is now known that the whole family of saturated hydrocarbons are found together right through the series from CH_4 to a heavy wax structure. This complicates matters, for there are many gases that have and many that have not sufficient suspended heavy compounds to yield paying quantities of gasoline condensates. Hexane ($\text{C}_6 \text{H}_{14}$), pentane ($\text{C}_5 \text{H}_{12}$) and butane ($\text{C}_4 \text{H}_{10}$) are the factors which, when present in sufficient quantity, warrant reduction to a liquid state for market. Hence, the prevalence

of these condensable constituents must be determined before attempting to compress the gas for their recovery.

One of the first steps is to find the specific gravity of the gas, although this cannot be depended upon entirely. For instance, family A, from one well or group of wells might consist of 10 per cent. methane, 30 per cent. ethane, 30 per cent. propane and 30 per cent. butane. The specific gravity would be about 1.43 (air = 1), and nothing could be produced from it marketable as gasoline.

Family B, from another well or group of wells, might consist of 60 per cent. methane, 5 per cent. ethane, 5 per cent. propane, 5 per cent. butane, 10 per cent. pentane and 15 per cent. hexane, in which case its specific gravity would be 1.26 and the 25 per cent. comprising the two heaviest constituents would yield a gasoline condensate, marketable as gasoline of at least 9 gal. per 1000 cu.ft. of gas.

The condensates yielded by the different gases are classified commercially into two general groups: natural gas gasoline and gasol. The first is the unrefined bulk of condensate as it is recovered from the gas and the second is the refined compounds derived by splitting the condensates into groups for different uses.

John Lathrop Gray secured the first broad patents relating to the production of gasoline from natural gas, and the writer, perceiving the need for further refinements, deviated from Gray's constant-pressure, constant-volume method by breaking the operation into steps for the purpose of drawing off fractions differing in specific gravity and boiling points. More recently, however, Dr. Snelling has added what appears to be the final touch of refinement which respects both the critical pressure and temperature characteristics of different compounds and enables the greatest nicety to be realized in the fractionation of the complex gaseous compounds into their several liquid states. It is needless to add that the gasol fractions must be retained and handled under restraint of considerable pressure when they approximate propane and the lighter compounds.

An important phase of the recovery of gasoline from natural gas is that separation is effected under physical conditions maintaining a close equilibrium between the liquid and the gaseous states. Because of its lightness as

compared to the mediums ordinarily handled by baffling and trapping, much difficulty has been experienced in eliminating uncertainties in the operations; hence, a vast amount of "cut and try" application.

Physically the product in appearance is white. It carries, usually, a very small (negligible) percentage of heavier oils, sometimes lubricant from the compressor cylinders. In time it evaporates to complete dryness comparable to and usually quicker than a refined oil product of equal heaviness. Its specific gravity varies widely, in different regions and with different pressures applied to obtain it, ranging from 0.625 to 0.71 (water = 1), or from 96 to 68 deg. Braumé.

As a fuel for gasoline motors its carbureting qualities are excellent. Consequently, the impression has become more or less general that its power value is much greater than ordinary refined gasoline. This is not true, except in the sense as the hydrogen ratio of a fuel increases, so does its gross fuel value.

Refined stocks, because much less volatile, can be stored without loss, while the new product cannot, even in winter, be stored in open tanks without loss. As fuel for light gravity gas lighting machines it is good, but its most fitting place seems to be in mixture with the refiners' low gravity gasoline or naptha fractions whereby a motor fuel of maximum power and the best carbureting characteristics may be had.

Many instances have already occurred in which the abandonment of a few small oil wells in oil fields has been saved by the installation of equipment to recover gasoline from their heretofore wasted gases. And it is not unusual for such wells to yield a greater amount of gasoline condensates than they do of crude oil. And as the condensates have a value at the well of about twice that of the oil, it can readily be seen how great a boon it is to the small oil operator whose revenue cannot be maintained sufficient for livelihood from the oil alone. The present production is about 2500 gal. per day.

What is claimed to be the largest steam turbine in existence is being constructed by Messrs. Brown, Boveri & Co., of Mannheim. It is a 35,000-hp. unit and will be coupled to a generator.

COMPRESSED AIR HUMIDITY PROBLEM

BY FRANK RICHARDS.

The following has to do with a case in which compressed air was used for blowing out electric generators, with the not unfamiliar result that the air jet delivered also more or less water, and the question arose as to how to be able to deliver dry air. It had been suggested that a change in the piping leading into and out of the air receiver would have provided the necessary relief, but it is here contended that much more than this was required.

To begin with, there is practically no such thing as dry air. So far as the water nuisance in compressed air practice is concerned, it generally makes little actual difference where the air is taken from, as all atmospheric air, free air, carries moisture, and when air is sufficiently compressed it has more moisture than it can carry, and then the released water becomes a nuisance or worse, as in the case under consideration. The problem is to get rid of the surplus moisture before it can cause trouble, and the conditions of air compression and transmission generally furnish the opportunity, however little it may heretofore have been availed of.

In the daily meteorological reports in the papers the humidity of the air is one of the most important items, and it shows a much wider range of fluctuation and more rapid changes than either the temperature or the barometric pressure, which suggests what an active business is done by the atmosphere in the water carrying line.

The capacity of air for moisture, up to the point of saturation, depends upon both its volume and its temperature. If the volume of any given quantity of air is reduced by compression, or increase of pressure, its capacity for moisture will be reduced in almost direct proportion. With a reported humidity of 50 per cent. for atmospheric air, which is not far from the average in many localities, if the air were compressed to 2 atmospheres, or say 15 lb., gage, then it would be saturated, or the humidity would be 100 per cent., or the air would have all the moisture it could carry in the form of intimately commingled vapor.

If the same air were compressed to 4 atmospheres, or say 45 lb., gage, then one-half of the moisture in it at the beginning would

immediately cease to be true vapor and would be condensed into real water, although it would still be distributed through the air in minute globules. If during the operations here suggested this air were enclosed in glass it would be seen to be perfectly transparent until the point of saturation was reached, and after that the condensed moisture would give it a misty or foggy appearance. This released water still in the air would wet anything with which it came in contact, and if the air was stationary or moving slowly in large pipes the water would gradually settle down through the air and be deposited along the bottom surface of whatever it was contained in.

For the air and its load of moisture to act as here described we have had to assume one impossible condition. We have ignored the fact that the compressing of the air always raises its temperature, and that the changing temperature of the air has more to do with its moisture carrying capacity than has the reduction of its volume. The hotter the air is the greater is its capacity for aqueous vapor, and the raising of the temperature of the air by the operation of compressing it increases its moisture carrying capacity more rapidly than the reduction of volume reduces that capacity, and the actual compression brings the air to the end of the operation sensibly dryer instead of wetter than at the beginning, although the actual water content has not been changed.

The moment, however, that the compressed air has been delivered by the compressor into the pipes or receiver its moisture capacity begins to change rapidly, because the temperature of the air falls at once. Unless the air is used immediately after it is compressed, and very near the compressor, its heat of compression is all dissipated, its temperature falls to that of its surroundings, and both the conditions of reduced volume and reduced temperature are combined in their effect to reduce to the minimum the vapor carrying capacity of the air and to set free a large portion of the water it contained when the compression began. The air will then inevitably be more than saturated with vapor and will contain actual water all through it, and it can only be described as very wet air.

If this air, without anything being done to it, is used for almost any mechanical purpose

the water will make itself manifest, and almost invariably in a more or less undesirable way, but if while the air is at its highest pressure and its lowest temperature the air is drained of its entrained water by passing through a separator—a steam separator of any of the usual types does the work very well—then the water will not be heard from later. If the air under full pressure is transmitted through pipes for a considerable distance the water will drop out of it and flow along the bottom of the pipe, and if this water is not drawn off from pockets which should be provided, then in the final rush of the air as it leaves the pipe to do its work the water will be picked up and carried along and will be just as bad as if it had never been deposited by the air at all. The actual separating and drawing off of the water after it has been released by the super-saturated air is a point which has been too frequently neglected.—*Practical Engineer.*

FOR THE COMPRESSIVE VENTILATION OF MINES

Rees H. Beddow, State Mine Inspector of New Mexico, writes in *Coal Age* of the advantages of the compressive system as compared with the exhaust system of mine ventilation. In the former system, he says, where the air is driven into the mine instead of being drawn out, the mine is ventilated under a pressure greater than that of the atmosphere, while in the exhaustive system of ventilation, the mine is ventilated under a pressure less than that of the atmosphere. To make this matter more clear, assume the atmospheric pressure (sea level) is 14.7 lb. per sq. in. or 2116.8 lb. per sq. ft. If the mine water-gage taken in the fan drift is 2 in., the ventilating pressure is $2 \times 5.2 = 10.4$ lb. per sq. ft., at this point. Then, assuming the efficiency of the fan is 60 per cent., the total pressure producing ventilation or circulating the air through the fan and the mine is $10.4 \div 0.60 = 17.3$ lb. per sq. ft.

When the fan is blowing the air through the mine (compressive system) the total pressure on the intake air is $2116.8 + 17.3 = 2134.1$ lb. per sq. ft. On the other hand, when the fan is exhausting the air from the mine, the pressure on the intake is the atmospheric pressure (2116.8 lb. per sq. ft.) and the pres-

sure on the air in the fan drift (return airway) is $2116.8 - 17.3 = 2099.5$ lb. per sq. ft. This shows a difference in the mine pressure, in the two cases, of 34.6 lb. per sq. ft., in favor of the compressive system. In my judgment, this difference in pressure is exerted to keep back much of the poisonous and inflammable gases that would otherwise enter the mine, and is one point in favor of the compressive system of ventilation.

FAST WORK IN A MINE DRIFT

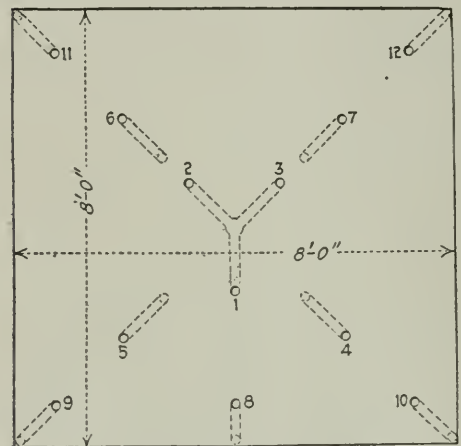
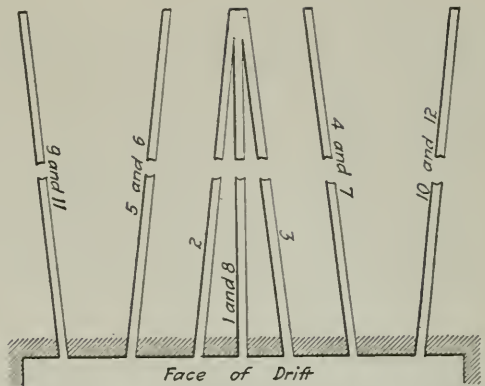
BY E. T. LEDNUM.

On Feb. 1, 1913, the Vinegar Hill Zinc Co. completed a double-track tramping drift at the Ellsworth Mine, near Livingston, Wis. (in the lead and zinc district). The drift is 8 ft. high and 8 ft. wide, and 391 ft. in length and was driven in 57 shifts of 9 hours each. The total time consumed was $37\frac{1}{2}$ days. Part of the time drilling was carried on during each shift but during the latter part of the work drilling and blasting were done on the night shift only and the muck was removed during the day shift. The drift was in the oil-rock formation of Galena limestone.

A part of the drift was driven by drilling but seven holes; three cut holes near the bottom in the middle of the heading, drilled to meet at the points; two bottom corner lifter holes, and two upper corner holes. In mineralized ground twelve holes were drilled, and the arrangement of these holes is shown in the accompanying cut. The cut holes Nos. 1, 2 and 3 were drilled to meet at the points and were, of course, fired first. The average advance per shift was 6.85 ft. The average advance per day was 10.4 ft.

One No. 8 Leyner drill was used, and all holes were drilled 12 ft. deep. The total amount of powder used was 6930 cartridges ($1\frac{1}{4} \times 8$ -in.) of du Pont forcite gelatin and du Pont low-freezing gelatin of 40 per cent. strength. The powder was exploded with Metallic Cap Mfg. Co. and du Pont No. 6 caps; 1012 caps were used and 7613 ft. of Climax-Crescent fuse.

During January the temperature dropped below zero, but at no time did the mining company find it necessary to thaw the du Pont new low-freezing gelatin in the thawing magazine. The powder was taken from the storage magazine into the mine at the beginning



LAYOUT OF DRILL HOLES.

of the shift and when drilling was finished the powder was ready for use. It was necessary to install a blower, and there was no ventilation. The work was under the direct supervision of Goodsell Billings, Superintendent — *Engineering News*.

CYANAMID AS A FERTILIZER

Nitrogen is the most important of the plant foods. It is usually the first element to become deficient in cultivated soils, yet when good forms and proper amounts are furnished, crops respond to it with a more direct and immediate effect than to applications of phosphate and potash. All the combined nitrogen now in existence on the earth's surface came from the atmosphere at some time or other. Previous to the discovery of Cyanamid the only practical means of fixing atmospheric nitrogen was by the action of bacteria. These

bacteria, themselves living on plants or plant refuse, take nitrogen from the air and combine it into chemical forms that plants can absorb. If plants were not removed, but were left to decay where they grow, the fertility of the soil would probably never decrease. When crops are removed, however, not only is the nitrogen carried away, but also the plant matter on which the bacteria feed. Then, in order to maintain fertility, it is necessary to restore combined nitrogen to the soil from other sources.

DISCOVERY OF CYANAMID.

The problem of artificially fixing atmospheric nitrogen into combined forms suitable for plant food has been investigated for a great many years, but not until 1895 was an adequate process discovered. In that year two German scientists, Drs. Frank and Caro found that when nitrogen from the air is conducted through a white-hot mass of calcium carbide (the material in common use for generating acetylene gas) there is produced a compound, known as Cyanamid, very rich in nitrogen. This form of combined nitrogen was found to possess particular value as fertilizer, and its use for this purpose has developed an enormous industry. Cyanamid factories have been established all over the world. One of the largest is located at Niagara Falls, where large quantities of electricity, required by the industry can be obtained at low cost. There are also four Cyanamid factories in Germany, two in France, and one each in Austria, Italy, Switzerland, Norway, Sweden, Japan and India.

Cyanamid is a dark-gray, odorless, dustless, granular material. It contains from 18 to 20 per cent ammonia, about 12 per cent. carbon, or lamp-black, and the equivalent of about 70 pounds of slaked lime. The material is shipped in regular fertilizer bags and can be stored indefinitely.

Cyanamid nitrogen is readily soluble. Ninety-six per cent. will dissolve out in cold water in twenty-four hours, and is, therefore, available as plant food. On contact with the soil it reacts quickly and forms first the organic compound, Urea (which is also contained in Peruvian Guano and Barnyard Manure), and then changes into the form of double ammonium compounds. These compounds are not leached or washed out of the soil, but are made available to crops by bacterial action and

the solvent effect of plant roots. This action insures a slow, steady supply of nitrogen that has the advantage of not overfeeding crops a few weeks and then starving them, but of supplying this element throughout their principal period of growth. Since the soil duration of Cyanamid nitrogen is from 60 to 80 days, crops are not fed when they should be maturing, and, therefore, ripen earlier and more uniformly.

OZONE—ALLOTROPY

If a current of oxygen is subjected to the action of a very high voltage oscillating discharge of electricity (several thousand volts) a part of the gas is converted into another substance, ozone. The physical properties of ozone are altogether different from those of oxygen. It has a peculiar odor, similar to that often noticed in the neighborhood of electrical machinery, and frequently observed after a thunder storm.

The density of ozone is $\frac{3}{2}$ that of oxygen, if both gases are measured under the same conditions. Ozone boils at a temperature of -110° C. (-166° F.), the liquid possessing a cornflower blue color. Liquid ozone is explosive, passing into ordinary oxygen with the liberation of a large amount of heat.

The relation between oxygen and ozone is a peculiar one, and both substances are said to be allotropic modifications of one element. While the physical properties are different, oxygen and ozone can be converted quantitatively into one another. The energy content of ozone is greater than that of oxygen. Also, oxygen and ozone react with the same substances, in the same proportions by weight to produce exactly the same substances. It is true that ozone, perhaps on account of its greater energy content, reacts more vigorously with certain substances than oxygen does. For example, silver is readily converted into its oxide by ozone, but only very slowly indeed by oxygen. But the oxide formed is the same in both cases.

Advantage is taken of the greater chemical reactivity of ozone, and it is now being extensively used for disinfecting purposes in hospitals, for freeing water from harmful bacteria, for sterilizing air in breweries and for purifying air in public buildings and subways, for preserving foodstuffs in cold storage, and for bleaching feathers, silk, wool and even cotton and linen.

HOW GOOD BRAKES SHORTEN THE RUNNING TIME

In 1907 the capacity of the Subway in New York was under consideration, and of course an effort was made to increase it. At that time it was increased by improving the brake. Strange as it may seem, they got over the road quicker by using better brakes and I believe at that time it was the only change that was made, and the capacity was increased very materially. In 1910 they were considering putting on larger motors in order to get sixty miles an hour instead of forty, and therefore get over the road in shorter time.

That looks perfectly natural, and yet under those conditions they would have actually consumed more time between stations than with conditions as they were. The reason for that is that when you double the speed of a train it takes four times the distance to stop, and in this case it would require more than twice the distance to stop; consequently, in such short runs as they have they would have made no material gain by using larger motors. Then it was suggested that they put on better brakes and stop sooner or in shorter distances. At first glance it didn't seem as though they could make much increase of capacity from this, but when it was pointed out that time saved by deceleration has a value equal to that saved by acceleration, and that a much more rapid rate of deceleration was obtainable, the possibility of increased capacity was apparent.

By a full use of the potentiality of the rail, practically all the power developed in the electric plants of New York and put into these trains, could be used to much better advantage. Nearly all of the amount which was waste product could, by making more efficient stops, be made into a by-product and therefore make a large gain to the railway company.

This is how it was done. The train possesses a certain energy. That energy can be dissipated in minutes or in seconds at the will of those in charge. If you dissipate it in seconds, it is obvious that you shorten your stop; in minutes, why, you consume that very element which the railway is built to save, namely, time. With better brakes a train with the old brakes on and one with the new

could leave a station together and with the cars equipped alike for power (a maximum of forty miles an hour) at the point where the old type had to apply its brakes the other one could continue to move under power for some distance, and thus the train with the new brake would be in the station to which it was going and its passengers discharged, other passengers on the train and clear, when the train with the old type reached the stopping place. This was done, and the time of stopping was cut down to one-half of that previously required. Thus the one train was moving with the power on for 20 seconds after the other had the brake on. Also the emergency stop was cut from 650 to 350 feet, so that the signal space could be shortened, and together the capacity of the subway was increased about 40 per cent. per day. This shows what can be done with the brake. It cost some money to do this, but not one-twentieth of what it would have cost to have obtained the same result by other means.

ANALYSIS OF EXPLOSIVES

The Analysis of Black Powder and Dynamite, is the title of Bulletin No. 51 recently issued by the United States Bureau of Mines.

This bulletin outlines the methods of analysis that are used in the examination of certain classes of explosives. The present form of most of these methods has been worked out in the bureau's explosives laboratory. The methods employed by Prof. C. E. Munroe were taken as a basis, and were elaborated to meet the demands incident to the treatment of complicated mixtures and to the development of the explosives art. This bulletin presents the methods of analysis of "Ordinary" dynamite, and the ammonia, gelatin, low-freezing, and granular dynamites, and the common grades of black gunpowder and black blasting powder. The bulletin is published by the bureau for the information of all persons interested in explosives and their safe and efficient use in mining work.

As the term "ordinary" dynamite, though much used, has no conventional meaning, and may be used to cover a wide variety of compositions of matter, it may be noted that the standard dynamite used at the Pittsburgh testing station is a good example of the "ordinary" dynamite known in this country. This

*Walter V. Turner, before Railway Club of Pittsburgh.

testing station dynamite has the following composition:

COMPOSITION OF PITTSBURGH TESTING STATION
DYNAMITE.

	Per cent.
Nitroglycerin	40
Sodium nitrate	44
Wood pulp	15
Calcium carbonate	1

As most permissible explosives contain only the constituents found generally in the various types of ordinary dynamite, the chemist will usually find it possible to analyze such explosives either wholly or partly by following the general methods of analysis given in the bulletin for the type of explosive that seems most closely related to the one under examination. The methods of extraction with ether, with water, etc., outlined in the bulletin are general methods which are applied with equal success to all classes of explosives, and therefore by the use of these general methods, following a thorough qualitative examination, little difficulty should be met, except with those classes of permissible explosives that contain large amounts of salts holding water of crystallization, such as alum and magnesium sulphate, or those containing an unusual number of uncommon constituents. Even with such explosives, however, if the information desired is principally in regard to the percentages of explosive ingredients (nitroglycerin, ammonium, nitrate, etc.), the methods outlined in this bulletin may be satisfactorily followed.

WORKING CONDITIONS FOR MINERS¹

There is always something happening to the air in a mine. In one way or another the oxygen is being absorbed, carbonic acid gas is being formed, and other bad gases are being generated. The breathing of the working men, the combustion of illuminants, and the exhalations from the veins and underground crevices all play their share. The miners' lamps or candles show the loss and decrease of oxygen by growing dim. If the oxygen falls even from 20 to 18, the ordinary lamp or candle will go out, and the workers grow blue in the face and sigh, yawn, and breathe irregularly. When this happens the working effi-

ciency of the miners will be seen to fall off as much as from 50 to 100 per cent. Weakness of arms and legs may occur and even fainting and loss of consciousness. Some men grow excited, sing, shout, and become rash and careless and fail to observe ordinary caution, not realizing the danger they are in. With increase of heat in the mines there is additional danger. Evaporation, radiation and sweating help to keep this down. By drinking lots of cold water miners are able to combat this heat and keep up their efficiency.

LARGE RECIPROCATING COMPRESSORS

The following dimensions and other particulars are given out concerning compressors furnished by Reed Meyer, of Mulheim on the Ruhr (Prussia), for mines on the Rand, South Africa:

Diameter of steam cylinders.....	31 & 62 in.
Diameter of air cylinders.....	54 & 33 in.
Common stroke.....	50 in.
Speed.....	65 to 72 r.p.m.
Free air intake per hr.....	565,000 to 644,500 cu. ft.
Total weight.....	176 tons.
Diameter of flywheel.....	21.8 ft.
Face of flywheel.....	26 in.
Total floor space.....	1,560 sq. ft.
Normal duty.....	1,700 to 1,750 hp.
Widths of air-cylinder pistons.....	52.75 and 44 in.
Diameters of air nozzles	
High-pressure side.....	17 in.
Low-pressure side.....	28 in.

The steam cylinders have the Doerfel positive valve-gear; the air cylinders Meyer disk valves for high rotative speeds. The steam end is run condensing and its cylinders are jacketed with live steam. The machine is unprovided with tail rods and guides, notwithstanding the long stroke rendered unnecessary by the construction of the air pistons.

The acceptance test showed the following results: Mechanical efficiency, 89.25 per cent.; volumetric efficiency, 98.7 per cent.; steam consumption, 11.28 lb. per i.hp.-hr. at a pressure of 172 lb., a temperature of 482 deg. F. and a vacuum of 25 in.; air temperature at a pressure of 89.5 lb. behind the low-pressure cylinder, 203 deg. F.; behind the high-pressure cylinder, 196 deg.; showing an advantageous working of the intercooler.

COMPRESSED AIR

MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

W. L. SAUNDERS, - - - - - Editor
FRANK RICHARDS, - - - Managing Editor
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We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

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Vol. XVIII. SEPTEMBER, 1913. No. 9

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THE GROWING BUSINESS OF THE AIR COMPRESSOR

We have in mind here the business, or the scope of employment, not of the compressor builder, but of the compressor itself, although quite naturally the one must keep pace with the other. Ever since the air compressor became a commercial product the rate of its production and the reach of its employment have had a race with each other to keep in touch with the opportunities, or, as we generally say it, the demands abreast and ahead.

In looking even casually and carelessly over the compressed air field, or say only through the pages of the present issue of COMPRESSED AIR MAGAZINE, one can scarcely fail to be impressed with the number and magnitude of the demands—actual demands—which are constantly being made upon the compressor as the only adequate means to satisfy them.

In the normal compressed air field the work increases along the established lines without let up. Not only do the mining, tunneling, caisson sinking, rock drilling, and such primitive customers of the air compressor grow with everything else, but practically all industries have now their special uses for compressed air, and an air compressor is a part of the installation of every power plant of any size.

But the air compressor is now much more than a compressor of air. It deals with all elastic fluids with equal facility, and it may yet come to be known generically, rather as a gas compressor.

Natural gas when it was first struck and made itself the talk of the world was quite independent of the compressor, having pressure enough to send it beyond the longest distances then contemplated for transmission, and new wells still coming into service have their initial surplus of pressure. This, however, soon changes when the well pressures fall and the pipes are extended, and there are already a great number of compressors of large capacity in the natural gas business.

Great numbers of compressors are already employed in the compression and transmission of artificial gas, but in this field we may expect to see an enormous increase of such employment. It is apparently inevitable that the example of high pressure natural gas transmission will be followed also by the artificial gas companies, and the growing demand of con-

sumers everywhere for pressures higher than those which are possible with the too familiar gas holder promises a demand for gas compressors practically wherever gas is manufactured in commercial quantities.

Then another sure and growing job for the gas compressor is in three and four-stage compression for the liquefying of air and for the charging of bottles for the transportation of the various commercial gases, oxygene, hydrogen, carbonic acid, etc. Further extensions of activities in these lines are clearly indicated by the trend of present practice.

AMERICAN MINE SAFETY ASSOCIATION

The annual meeting of the American Mine Safety Association composed of leading coal and metal operators, mining engineers, mine-safety engineers, and mine surgeons will be held in Pittsburgh, Pa., September 22-24.

Since fifty-eight per cent. of all industrial accidents are shown by statistics to be due to negligence, carelessness or lack of knowledge of employers or employees, the vital necessity of learning everything possible about the causes and means of preventing these accidents must be evident to every man concerned in mining. To the operators it spells business success or failure; to the miner, life or the physical ability to work and support a family.

LONGEST TUNNEL IN SOUTH AFRICA

The Stockton tunnel, in Natal, is described by Mr. A. Colman, assistant engineer on the South African Railways, in a recent number of the "South African Railway Magazine." The tunnel is 2586 ft. long, through what is considered probably the hardest class of rock in Natal. Headings 9x9 ft. were started simultaneously at each end, but one was a top and the other a bottom heading, the former being used because the approach cut at that end was not deep enough at the time to permit a bottom heading. At the south end the top heading was driven as fast as possible, the widenings on each side following close behind, after which most of the bottom section was removed, leaving a wide enough bench along the side for a tramway to haul out the material from the heading. At the north end timber stagings of 12x12-in. timbers, with 4-in. flooring, were erected at intervals at the top of the heading after it had been widened. The head-

ings were started about May 1, 1912; they met Feb. 22, 1913, and the excavation is now practically completed. The tunnel will be lined with concrete.

AUTOMOBILE POWER TRANSMISSION BY COMPRESSED AIR

Two Frenchmen, convinced of its value, have brought out a car in which air is made the medium through which the power of the engine is transmitted to the driving wheels. According to the system, the engine has four cylinders, set in a V, two of which act as pumps to compress the air in a tank hung to the chassis. From the tank, the air is admitted to two other working cylinders direct connected to the rear axle of the car. In operation, the system works on the same general principle as do hydraulic transmissions, with the important difference, of course, that the air is a great deal more elastic than is the oil in other systems; hence great claims are made for the air system. At present it is being tested out, and though its efficiency has not been demonstrated to be very high, it is expected that its simplicity and flexibility will overcome the disadvantage of its inefficiency. Enough air is constantly stored to make the vehicle self starting.

INGERSOLL-RAND PRODUCTS

This is a publication of 140 pages, standard catalogue size, 6 by 9 in., copiously illustrated and beautifully printed, enumerating and briefly describing the various types of air compressors, rock drills, pneumatic tools, etc., with their many developments and appurtenances. The most essential particulars as to sizes and capacities are given in tabulated form, while full details may be obtained from special publications for each item, which are furnished as they may be called for. There are 25 pages of tables and data which will be welcomed by all who have to do with the line here represented.

A vest pocket edition of the above, a complete fac simile, page for page, of the entire publication, comprises one of the daintiest and handiest business reminders ever issued. It is 4x2 3/4 x 3/4 in., bound in leather. It is something that any one would be glad to get hold of and to keep about him. Either of the above will be sent to any one who will ask for it.

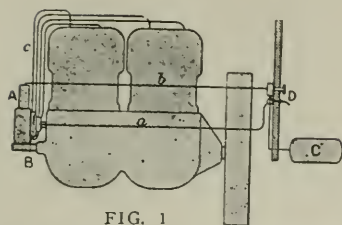


FIG. 1

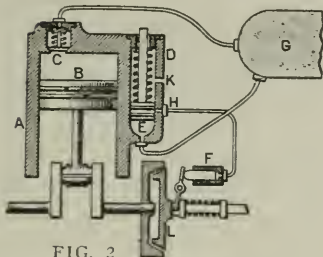


FIG. 2

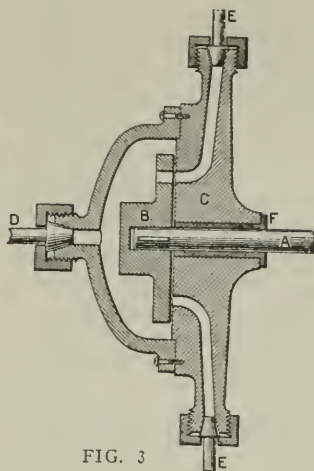


FIG. 3

COMPRESSED AIR MOTOR STARTERS

Given the choice of starting an automobile motor either by means of a special explosive charge, such as one formed from acetylene gas or by a forcible injection of gasoline vapor, or by an electric motor or by a compressed-air motor, the French market is developing a preference for the latter form of auxiliary.

Among the compressed-air devices, some act directly on the motor shaft, and others send the air to the cylinders to act upon the pistons, one after another, until the motor is running normally.

The first of these types does not depend upon finding the motor pistons in a certain position to start with and is represented in the

Barbey self-starter which is used on Delaunay-Belleville cars and consists in a four-cylinder air motor mounted in front of the gasoline motor and arranged to be clutched to the motor shaft. It receives compressed air from a tank on the dash when the motor is to be started and, on the other hand, is driven by the gasoline motor when the tank must be re-filled.

On account of the smaller equipment involved, greater interest attaches to the second type. It is based on the ascertained fact that a gasoline motor in good order always comes to rest with all of the four pistons at the same height and that one of them therefore always is in the position of a half-finished power stroke. If air is sent to the cylinder where

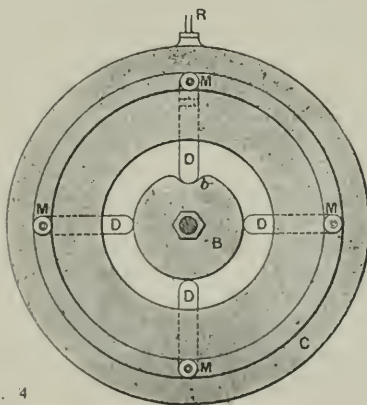
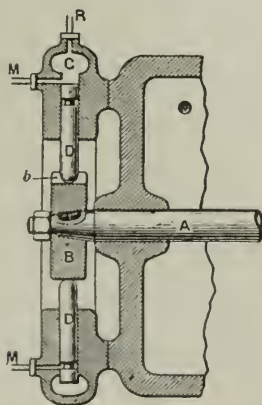


FIG. 4

the piston is in this position, it will thus act upon this piston exactly as the gas explosion acts during normal operation, and in order to effect a start safely it is only necessary to arrange a distributor device which will send air first to the cylinder which is found in the position referred to and successively to the other cylinders in the order in which they get into the same position. As soon as the speed imparted to the crankshaft is sufficient to draw an ignitable charge into one of the cylinders and to effect the compression of the same, the start is bound to follow, and the moment an explosion occurs from which the pressure is greater than that of the air, the automatic valves in the distributor cease to admit air.

All the apparatus necessary for assuring this result comprises a special distributor device connected to the different cylinders by tubes of small diameter, a special automatic intake valve for the compressed air in each of the cylinder heads and an air-tank connected to the distributor. The compressed air is usually produced by means of a small pump actuated at the driver's option from one of the gear shafts, and it is usually sent first into a small reserve tank. The general arrangement is shown in Fig. 1, in which A is the air-tank, B the distributor, C the reserve tank, D the control organs, *a* tubes from the reserve, *b* tubes to the reserve and *c* tubes to the cylinders. The distributor is the only organ presenting features not familiar from other mechanical devices. It must be so built as to avoid air leaks when it is feeding the cylinders and to avoid friction when it is not operating. Fig. 3 shows one such arrangement. A is a half-speed shaft driven from the crankshaft, B a rotary slide valve keyed to rotate with A but capable of a small longitudinal displacement on the shaft, C the distributor-disk forming one side of the air-collector in which air is received through the valve D from the air tank, E the air conduits to the cylinders, F the bushing in which shaft A turns. The air pressure holds the ground face of the rotary slide valve tightly against the distributor-disk C, as soon as air is admitted. The hole in the slide valve can be made large enough—in the form of a curved slot—to make sure that air will reach one of the cylinders when first admitted, even if the pistons are not found strictly midway between centers,

and thereafter the slide valve is rotated and takes care of the successive distribution to the four cylinders. When the start is effected and the air supply is cut off, the slide valve is detached from the face of the distributor and revolves without friction. This device need only be from $2\frac{1}{2}$ to 4 inches in diameter.

A somewhat different distributor is used in Delahaye fire engine motors and has so far proved itself reliable. It was designed and made by Letombe and Aucoc and is shown in Fig. 4. It forms a feature in a general arrangement like that represented in Fig. 1. This distributor has four piston valves D placed 90 degrees apart around a cam disk B keyed upon the camshaft of the motor. The space at the outer ends of the pistons is in constant communication with an annular space C in which the compressed air is received by way of R, and from which four conduits M lead to the cylinders. When air is admitted, all the pistons are pressed against the cam-disk, but only the one opposite to the notch *b* in this disk can be displaced toward the center of the device, thereby uncovering the corresponding air conduit to one of the cylinders. When the air pressure ceases, the pistons also cease to press against the cam disk and the device revolves without appreciable friction.

The intake valve for the air which must be provided in each of the motor cylinders opens from the outside inwardly and its spring must be strong enough to resist the ordinary suction of the intake stroke, for which purpose a four pound spring pressure [per square centimeter] is sufficient, even if the carbureter is throttled down.

A compressed-air motor-starter can be arranged so as to require no attention with regard to the filling of the air tanks. To this end, the compressor pump is connected with one of the shafts in the motor by a cone clutch on the plan shown diagrammatically in Fig. 2. A is the compressor cylinder with piston B and valve C connected by a tube with the air tank G. In the adjacent small cylinder D the piston E is pressed toward the bottom by a spring, against the resistance of the air pressure underneath. If sufficient to raise the piston until the port H is uncovered, the air pressure travels through a tube to the small cylinder F and drives the piston in the latter against a lever which disengages clutch L and releases the compressor shaft from the driving

shaft. Obversely, if the air pressure under piston E is low, the clutch spring pushes the clutch into engagement and puts the compressor to work. K is a safety port limiting the air pressure to a maximum, being necessary because a relief port in cylinder F, for example, would leave too small a margin of air pressure to work with, so that the clutch would be continually engaging and disengaging.

AN ILLUMINATING PROJECTILE

Deutsches Offizierblatt describes an illuminating projectile of a new type manufactured by Krupp. The projectile, built like a shrapnel, contains a number of layers of flame bulbs in a black powder matrix separated by thin annular partitions. A black powder fuse runs through the center of the projectile, like a core. The base of the projectile is filled with six "feathers" made of thin metal, which are held in place, folded up against the projectile, when it is fired. When the projectile reaches the highest point in its trajectory, an automatic arrangement releases the "feathers" at the base, arresting its flight and causing it to float in the air point downwards. At this moment the first layer of flame balls is thrown out. The other layers are thrown out successively, lighting up the field.

NOTES

Brazil has recently decided to join the great nations of the world in the use of the meridian of Greenwich for reckoning official time, it heretofore having been one of the few commercial nations to prefer its own meridian.

In patent No. 1,064,053, A. R. Coyle, Jr., of Trafford, Penn., shows a hair-cutting apparatus which is provided with cutting blades operated by means of a vacuum and the vacuum also serves to draw the hair to be cut into the path of the blades or cutters and delivers the cut hair to a suitable receptacle.

Bulletin No. 56 of the Bureau of Mines, entitled "First Series of Coal Dust Explosion tests in the Experimental Mine," by George S. Rice, L. M. Jones, J. K. Clement and W. L. Egy, which is sent free to any one who asks for it, has been prepared for the purpose of

placing before the mining public an account of the objects sought in the establishment of the experimental mine of the bureau, a description of the arrangement and equipment of the mine and a detailed account of the first series of explosion tests, including a description of the recording apparatus used in connection with them.

The activity in building war materials in Russia is indicated by the consumption of gas for acetylene welding. One shop near St. Petersburg has an hourly consumption of 300 cu.m. (10,600 cu.ft.), and this for each hour of the 24. This is believed to be the largest use of gas for flame welding in a single plant in the world.

A pneumatic tire well inflated runs cooler than one "underflated", the reason being that the generation of heat is largely due to the flexing of the fabric in the casing. The lower the inflation the more the flexing, and correspondingly the greater the heat generated and the more danger of devulcanization of the rubber in the casing.

Eliantite is a new alloy, prepared in the electric furnace, which is particularly resistant to acids. It is not attacked by chlorine or bromide in a free condition, by hydrochloric, sulphuric or nitric acids, or by *aqua regia* made up of three parts of hydrochloric acid to one of nitric acid. The specific gravity of eliantite is 6.8 and its melting point is 1,250 degrees Cent. (2282 F.).

Notwithstanding the high prices prevailing for tin, the increase in the world's production in the last few years has been but slight, and as compared with the output of 1910, has decreased. In 1911, the world's production of tin aggregated 118,200 tons. Although tin is used extensively in the brass foundry industry, nevertheless, the largest tonnage is consumed by manufacturers of tin plate.

A recently developed branch of the aluminum industry is the manufacture of the powdered metal known to the trade as aluminum-bronze powder and used extensively as a paint pigment, in explosives, in lithographing, and in printing. To make the powder, foil made of the metal only 0.01 millimeter (0.0004 inch)

thick is cut into squares of 2 millimeters, or 0.079 inch, on a side and rubbed to a powder. The material feels like powdered graphite and is just as difficult to remove from the skin.

Ammonia bombs are being tried out on some of the national forests for the purpose of extinguishing forest fires. They are said to have worked well in the case of brush fires where the fire-fighters find difficulty in getting near enough to the burning area to beat out the flames.

It is not known what constitutes "good" air or "bad" air. Oxygen we know is necessary, but there must be something else. Some have thought that it is ozone, but this is far from proven. The scientists have never been able to locate any toxic poison in bad air. Any number of latest authorities can be quoted on the subject of the harmlessness of carbonic acid; even the fact that the amount of carbonic acid is a reliable index of other impurities is being doubted.

Eugene Gilbert, a French aviator, on August 3, flew from Paris to the town of Pejabo, on the Portuguese frontier, a distance of 1,030 miles, in an effort to win the Pommery Cup which is given for the longest flight in a single day. Gilbert beat the record of 875 miles made on June 11 last by des Moulinais, flying from Paris to Warsaw. Gilbert left Paris at 4.45 a. m., and flew for 7 hours without a stop to Victoria, in Spain, where he landed. Ascending again at 1 p. m., he headed for Portugal, and at 8 p. m. descended at Pejabo.

As an extinguisher for small fires of gasoline or oil, sawdust is better than sand. Plain ordinary sawdust, wet or dry, thrown on the blazing fluid, has a blanketing action, floating on the surface and keeping out the air, so that it actually smothers the flame. Sand is less efficient because it sinks through the liquid, and acts to smother the flame for only a short period. The efficiency of sawdust may be increased by mixing it with sodium bicarbonate, at the rate of 10 pounds of bicarbonate to a bushel of sawdust. The bicarbonate liberates carbon dioxide when heated, this gas smothering the flames.

LATEST U. S. PATENTS

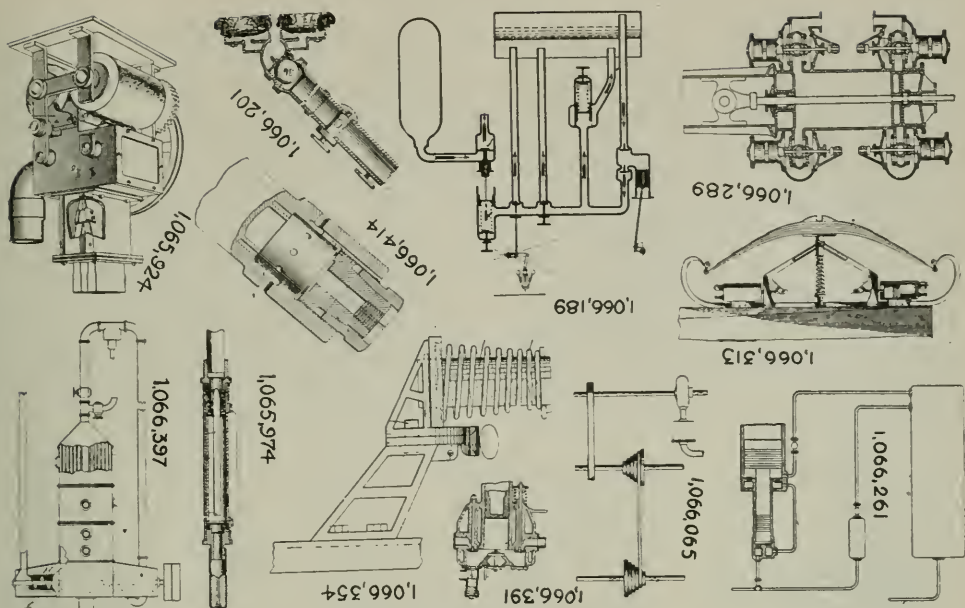
Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JULY 1.

- 1,065,924. PNEUMATIC VALVE. AMOS F. DIXON, Newark, N. J.
- 1,065,974. DEVICE FOR TESTING PRESSURE, SPECIFIC GRAVITY, AND VOLUME OF GASES. SAMUEL C. SHAFFNER, East Orange, N. J.
- 1,066,065. METHOD OF PRODUCING SO-CALLED OZONIZED AIR. JAMES TODD, Sewickley, Pa.
- 1,066,066. AIR-VALVE. LOUIS A. VIDY, Ogden, Utah.
- 1,066,189. APPARATUS FOR REGULATING THE PRESSURE AT WHICH AIR IS BLOWN INTO INTERNAL-COMBUSTION ENGINES. LUDWIG THADDAUS EBERMANN, Augsburg, Germany.
- 1,066,201. VACUUM-MOP. JOHN W. FULPER, Annadale, N. J.
- 1,066,260. PNEUMATIC STRAW - STACKER. AUGUST P. DETERMANN, Lyons, Iowa.
- 1,066,261. AIR COMPRESSING AND STORAGE APPARATUS. RUDOLF DIESEL, Munich, Germany.
- 1,066,287. VACUUM CARPET - SWEEPER. GOTTLIEB KLUMPP and PAULINE KLUMPP, Bayonne, N. J.
- 1,066,289. VALVE-GEAR FOR RECIPROCATING STEAM AND OTHER ENGINES. STANISLAS KOLOMYJSKI, Alexandrovsk, Russia.
- 1,066,313. PNEUMATIC SHOCK-ABSORBER. LLOYD E. PARROTT, Topinabee, Mich.
- 1,066,354-5. TURN-TABLE FOR COUPLINGS. LEONIDAS DOAN WOODRUFF, Hattiesburg, Miss.
 - 1. A turn-table for fluid pressure coupler heads comprising a stationary plate designed to be attached to the draw bar of a car coupler, a second plate pivoted to said stationary plate and adapted to receive a coupler pipe, and a lever carried by said stationary plate and adapted to engage the other plate to hold the plate carrying the pipe in different adjusted positions, as set forth.
- 1,066,391. PRODUCER OF INERT GASES. HERMANN VON EICKEN, Friedenau, near Berlin, Germany.
 - 1. The combination with an internal combustion engine, of a compressor, a connection for leading the exhaust gases of the engine to said compressor, a delivery conduit, a valve controlling the passage of the compressed gases from the compressor to said conduit, a piston held to move in unison with said valve and having a face exposed to the gases contained in the delivery conduit to counteract the pressure exerted by said gases on the valve, and means for pressing the valve toward its seat.
- 1,066,397. PROCESS AND CONTRIVANCE FOR PRODUCTION PARTICULARLY OF SUGAR-CRYSTALS IN VACUUM. OTTO FROMM and MATTHIAS SCHODLY, Schwartau, near Lubeck, Germany.
- 1,066,414. PNEUMATIC TOOL. HENRY E. LE GENDRE, Cresskill, N. J., and GEORGE LEICH, New York, N. Y.

JULY 8.

- 1,066,483. FLUID-PRESSURE MOTOR. JOHN FOURNIA, Albany, N. Y.
- 1,066,484. OZONE-GENERATOR. WILLIAM O. FREET, Hackensack, N. J.
- 1,066,523. PROCESS FOR THE SCIENTIFIC CURING OF WOODS. FRANK A. PALEN, New York, N. Y.
 - 1. The herein described process of curing wood, which consists in first subjecting the undried wood to combined action of a vacuum and a progressively increasing temperature, then breaking the vacuum and subjecting the wood to heat alone to produce a substantially uniform



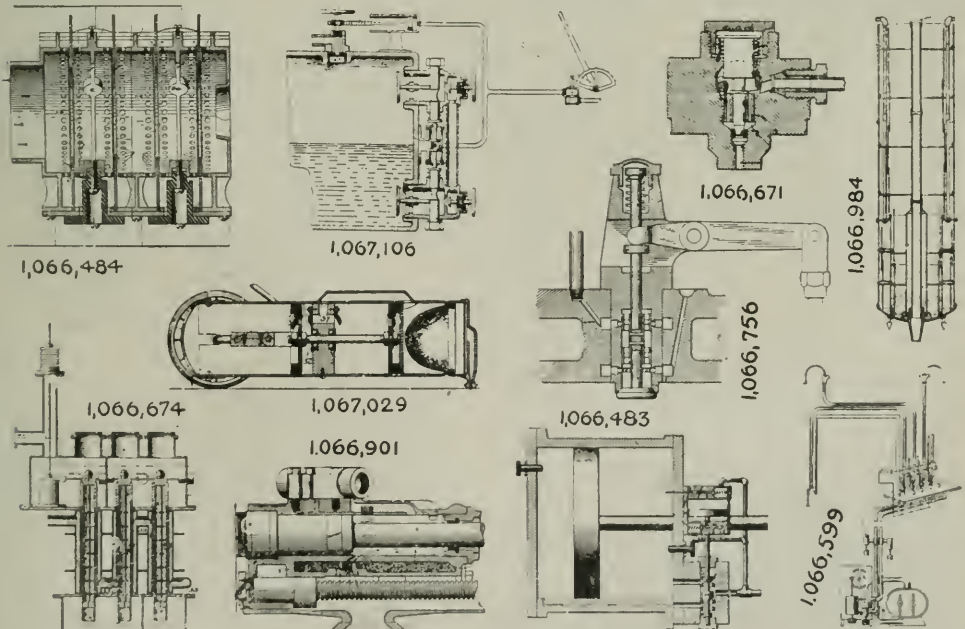
PNEUMATIC PATENTS JULY 1.

temperature throughout the entire mass without decomposition of the wood resins, and then subjecting the wood to the combined action of a vacuum and heat for causing distribution of the wood resins in an undecomposed form.

1,066,599. PNEUMATIC - DESPATCH APPARATUS. OWEN G. GILSTRAP, Portland, Oreg.

1,066,671. VALVE - ACTUATING MECHANISM FOR INTERNAL - COMBUSTION ENGINES. KARL STEINBECKER, Charlottenburg, Germany.

1. In a device of the character described, the combination of a body, a fluid pressure seated valve located therein, an actuator one end of which extends into the fluid space and acts

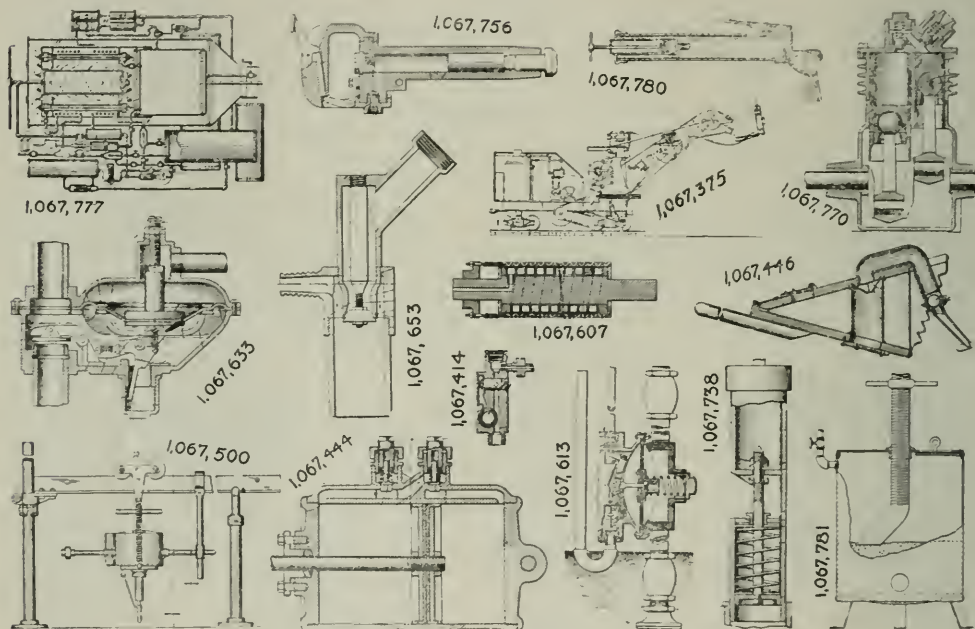


PNEUMATIC PATENTS JULY 8.

through lost-motion on the valve, and a means operated by a machine part for moving the actuator

- 1,066,674. APPARATUS AND METHOD FOR THE PRODUCTION OF OZONE. JAN STEYNIS, New York, N. Y.
- 1,066,756. AIR STARTER AND RELIEF VALVE. CLAUDE RORABECK, Dayton, Ohio.
- 1,066,901. ROCK-DRILL. CHARLES C. HANSEN, Easton, Pa.
- 1,066,927. POWER-PNEUMATIC FOR PLAYER-PIANOS. JOSEPH LEISCH, Tyron, N. C.
- 1,066,984. CAISSON CONSTRUCTION. EDWARD BIGNELL, Lincoln, Nebr.
- 1,067,029-30. PUMPING MECHANISM FOR VACUUM-CLEANERS. ROBERT B. HUTCHISON, Wilksburg, Pa.
- 1,067,106. DEVICE FOR AUTOMATICALLY CLOSING LOCOMOTIVE-VALVES. THOMAS W. GRIFFIN, Springfield, Mo., and CURTIS J. RATHERS, Sapulpa, Okla.
1. A device of the character described, comprising the combination with valved cab fittings

- 1,067,446. VACUUM-CLEANER. THOMAS R. SCHAFFOS, Georgetown, Colo.
1,067,500. PNEUMATIC DRILLING - MACHINE. JAMES H. BONDY, Great Falls, Mont.
1,067,607. PNEUMATIC ROLL FOR LEATHER-WORKING MACHINES. HENRY A. HOLDER, Lynn, Mass.
1,067,613. PNEUMATIC PUMP. GEORGE S. LANE, Portland, Ore.
1,067,633. AUTOMATIC CHECK-VALVE FOR GAS. JOHN ZANDER, Chicago, Ill.
1,067,653. VACUUM - CREATOR. EDWARD HEARING, Kellogg, Idaho.
1,067,658. DEVICE TO TRIM HORSES' HOOF'S. MICHAEL JOYCE, Jr., Burdette, S. D.
1. A device of the class described comprising as constituent parts, a casing and a tool carried by the casing, one of which constituent parts is provided with a lubricant outlet discharging upon the outer face of the tool; and a unitary means for imparting a blow to the casing and for creating a fluid pressure within the casing above the outlet.



PNEUMATIC PATENTS JULY 15.

the valves of which are normally open, and a source of air supply, of connections whereby to automatically close the valves upon the application of the emergency brakes, and prevent the escape of steam and boiler water into the cab in the event that the fittings are broken.

JULY 15.

- 1,067,375. ROCK-BREAKING SHOVEL. OLIN S. PROCTOR, New York, N. Y.
1. The combination with the dipper of any preferred type of power shovel of pneumatic hammers suitably located on said dipper for breaking rock, substantially as described.
- 1,067,383. ROCK-DRILLING MACHINE. DANIEL SHAW WAUGH, Denver, Colo.
- 1,067,414. PNEUMATICALLY - OPERATED GAS-VALVE. ALFRED NEVILLE EDWARDS, London, England.
- 1,067,444. SHOCK-ABSORBER. THOMAS F. SCOTT, Everett, Mass.

- 1,067,728. AUTOMATIC RELEASE - VALVE FOR AIR-BRAKE SYSTEMS. CHARLES W. HURL, Johnstown, Pa.
- 1,067,756. PNEUMATIC TOOL. EDMOND W. RAIKES, Cleveland, Ohio.
- 1,067,759. AIR-CLEANER AND VENTILATOR. HENRY M. ROBERTSON, St. Paul, Minn.
- 1,067,770. TWO - STAGE COMPRESSION-PUMP. GREGORY JOHN SPOHRER, Franklin, Pa.
- 1,067,771. MEANS FOR GENERATING MOTIVE FLUID FOR MOTOR-CARS. FRANK H. STANARD, Denver, Colo.
1. In apparatus of the class described, the combination of a steam generator, a dome in communication with the generator for receiving the motive fluid, a compressed air receiver, a water tank, an injector connected in operative relation with the receiver, the water tank and the generator, and means operated by the motive fluid from the dome for automatically cutting off the supply of air and water from the in-

jector to the generator, substantially as described.

1,067,780. DISTRIBUTER. FRANK J. BRINK, Cincinnati, Ohio.

The combination of a tubular container, a brush secured on one end thereof at an angle to its length, valve controlled tubular connections therefrom with the container, a cap removably secured on the other end of the container, and an air compressor secured to the cap for regulating the air pressure within the container in discharging the contents thereof to the brush.

1,067,781. CONCRETE-MACHINE. WILLIAM L. CANNIFF, deceased, by Roy L. Canniff, administrator, New York, N. Y.

1. In a device of the character described, the combination of a vessel adapted to contain concrete or concrete materials, provided with an opening for supplying the same to the vessel, a door for closing said opening, means for injecting air under pressure into said vessel above the upper surface of the concrete and a discharge pipe said discharge pipe extending from the surface of the said concrete to the outside of the vessel at a point above the said concrete and having an intake opening in proximity to the said surface, and means for maintaining the said opening in such proximity during variations in the quantity of concrete in the vessel.

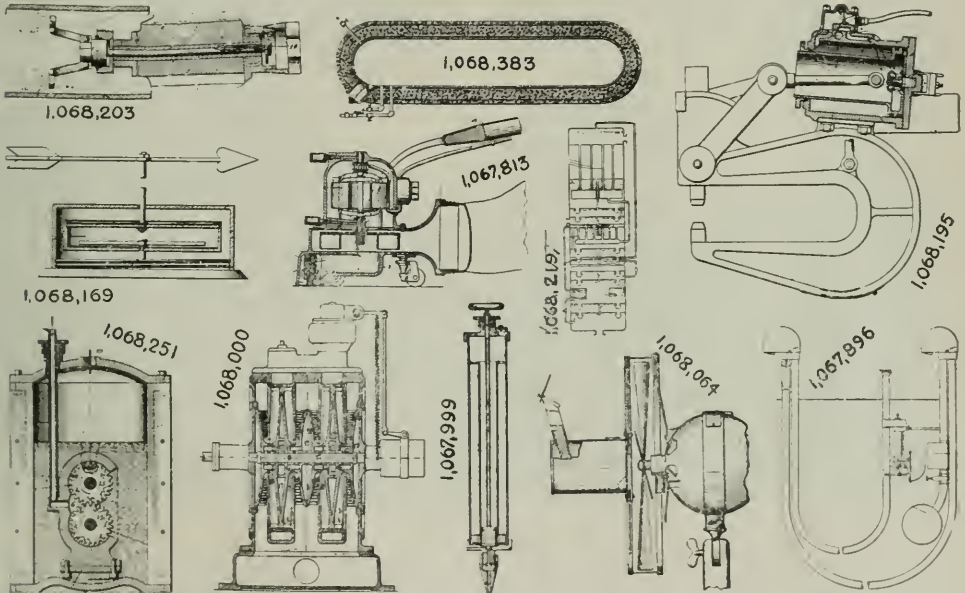
1. A fire extinguishing hand-syringe comprising in combination a reservoir, a pumping chamber adjacent thereto, a piston adapted to be reciprocated repeatedly within said pumping chamber to empty the same, said pumping chamber communicating with said reservoir at the forward and rear ends of said pumping chamber, and an air inlet valve for admitting air on the forward stroke of said piston and preventing an outward flow of air on the back stroke of said piston whereby the air in the rear of said reservoir is compressed, and the flow of liquid accelerated from said reservoir into the forward end of said pumping chamber, and means for preventing a return flow of the liquid from the forward end of said pumping chamber to said reservoir on the forward stroke of said piston.

1,068,000. COMPOUND FLUID - PRESSURE TURBINE. LEON METAIS, Charenton, France.

1,068,064. APPARATUS FOR MOISTENING, DEODORIZING, DISINFECTING, PERFUMING, AND COOLING AIR. FELIX LESSER and ARTHUR H. AVERY, New York, N. Y.

1,068,162-3. PNEUMATIC CONCENTRATING-TABLE. CLARENCE Q. PAYNE, New York, N. Y.

1,068,169. WIND-INDICATOR. GEORGE W. RICKETTS, Philadelphia, Pa.



PNEUMATIC PATENTS JULY 22.

JULY 22.

1,067,802. VACUUM-HEAD FOR COTTON-PICKING MACHINES. WOODBURY K. DANA, Westbrook, Me.

1,067,813. VACUUM-CLEANER. HARMON H. HAROLD, Canal Dover, Ohio.

1,067,896. PNEUMATIC - DESPATCH - TUBE APPARATUS. BIRNEY C. BATCHELLER, New York, N. Y.

1,067,969. PNEUMATIC ACTION FOR PIANO-PLAYER, &c. GEORGE P. BRAND, New York, N. Y.

1,067,970. WINDMILL. WILLIAM P. BRETT, Decatur, Ill.

1,067,984. AIR-GUN. WILLIAM A. HEILPRIN, Philadelphia, Pa.

1,067,999. FIRE-EXTINGUISHING SYRINGE. HIRAM MERRITT, Newburgh, N. Y.

1,068,195. POWER DEVICE. MORRIS C. WHITE and OTHO C. DURYEA, Chicago, Ill.

1,068,203. TUBE - CLEANER. THOMAS ANDREWS, Rockaway, N. J.

1,068,219. PROCESS FOR SEPARATION OF THE CONSTITUENTS OF GASEOUS MIXTURES. GEORGES CLAUDE, Paris, France.

1. A process for the separation of a mixture of gases, such as air, into its constituents by way of liquefaction followed by rectification of the liquid produced, consisting in passing the compressed and cooled gases through a laterally confined space cooled by liquid collected at the foot of the usual rectification column, and then passing the remaining unliquefied gases in continuation through a second laterally confined space cooled by liquid collected in the column in a region situated some distance above the foot of the column.

1,068,228. CAISSONS AND METHOD OF JOINING THEM. JOHN W. DOTY, Brooklyn, N. Y.

1,068,251. ROTARY PRESSURE OR VACUUM PUMP. GEORGE I. LEONARD, Los Angeles, Cal.

1,068,383. CONCRETE COMPRESSED - AIR CISTERN. WILBUR T. CLARK, Buffalo, N. Y.

A cistern comprising, cylindrical concrete side walls and spherical ends, a wire mesh reinforcement therefor and embedded therein, a unitary complete metallic shell disposed within the said concrete and defining a liquid-tight compartment, said metallic shell formed of thin material and adapted to retain a liquid out of contact with the concrete which forms the side walls and ends, a metallic man-hole tube extending through an opening formed in the said concrete side wall and effecting a liquid-tight joint with the said metallic shell, means for the closure of said man-hole, and means for supplying a liquid to said cistern, the delivering of the

1,068,589. POWER - OPERATED CONTROLLING MECHANISM FOR FLUID - ACTUATED MACHINES. REYNOLD JANNEY, New York, N. Y.

1,068,596. ELASTIC - FLUID TURBINE. CLINTON E. LONG and FREDERICK R. LONG, Berwick, Pa.

1,068,605. PNEUMATIC HAMMER. GEORGE L. ROBERTSON, Philadelphia, Pa.

1,068,635. VACUUM CLEANING APPARATUS. ELIAS B. DUNN and ARTHUR F. DUNN, East Orange, N. J.

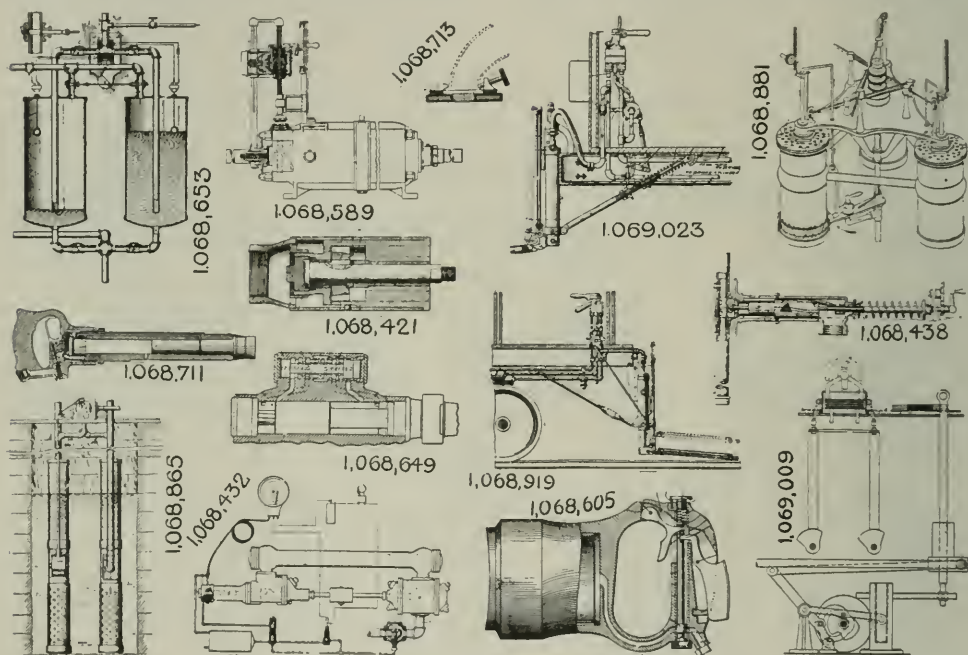
1,068,649. VALVE FOR PERCUSSIVE TOOLS. CHARLES C. HANSEN, Easton, Pa.

1,068,675. SAFETY RELIEF DEVICE FOR GASES UNDER PRESSURE. CECIL LIGHTFOOT, Buffalo, N. Y.

1,068,711-2. PNEUMATIC TOOL. ALBERT H. TAYLOR, Easton, Pa.

1,068,713. PNEUMATIC CLEANING - TOOL. CHARLES R. THURMAN, Parnassas, Va.

1. An attachment for pneumatic tools comprising a facing member provided with a slot, a



PNEUMATIC PATENTS JULY 29.

liquid from said cistern, and the supplying of a pressure above the liquid within the cistern.

JULY 29.

1,068,421. MOTOR. WILLIAM S. ELLIOTT, Pittsburgh, Pa.

1. A fluid pressure motor, comprising an outer shell, front and rear shaft bearings contained within the shell and removable from the front end of the shell, means whereby a motor element may be inserted intermediate the shaft bearings, and means at the rear end of the casing or shell for securing the parts within the shell; substantially as described.

1,068,427. ENGINE-STARTING APPARATUS. EDWARD A. HALBLEIB, Rochester, N. Y.

1,068,432. THERMAL CONTROL FOR AIR-COMPRESSORS. EBENEZER HILL, Norfolk, Conn.

1,068,438. BLOWER FOR WATER - TUBE BOILERS. JOHN MAGEE, Detroit, Mich.

cloth facing enveloping said facing member, and a clamping plate connected with said facing member and provided with means for securing the same to the mouth of the pneumatic tool.

1,068,798. SAFETY-VALVE FOR PNEUMATIC TIRES. WARREN W. MCCREARY and JOHN G. MYERS, Pasadena, Cal.

1,068,865. PUMP. GEORGE DORFFEL, Oakland, Cal.

1,068,881. FLUID - EXPANSION ENGINE. JOSE IGNACIO FORTOUL, deceased, Caracas, Venezuela.

1,068,919. CONTROLLING - VALVE FOR FLUID-PRESSURE-OPERATED FENDERS. FRANK A. NELSON, Minneapolis, Minn., and HARRY E. GILHAM, Seattle, Wash.

1,069,009. APPARATUS FOR PNEUMATICALLY SEPARATING SHEETS. JACOB HEINRICH, Nuremberg, Germany.

1,069,023. CAR-FENDER. FRANK A. NELSON, Minneapolis, Minn., and EINAR T. FLATEBOE, Seattle, Wash.

COMPRESSED AIR

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FIG. 1. A TYPICAL COTTON MANUFACTURING PLANT. MILL OF THE CHICOPEE MFG. CO., CHICOPEE FALLS, MASS.

COMPRESSED AIR IN THE COTTON INDUSTRY

BY C. C. PHELPS.

From the moment that the raw cotton is picked until the bolts of fabricated goods are ready to leave the factory, air, in various degrees of compression or expansion, plays an important part in assisting in the various stages of manufacture.

REMOVING THE COTTON SEEDS.

The ripe cotton bursts from its boll or containing capsule and is then picked by hand.

The cotton, as it is picked, consists of a woolly, fibrous material in which the individual fibres vary in length up to two inches (depending upon the kind of cotton, locality, etc.) and a large number of seeds embedded in the fibrous material. The first process encountered is the removal of these seeds and any large particles of foreign matter. The cotton gin is universally used for this purpose. In the days when Eli Whitney gave to the world the cotton gin, the cotton-seed was regarded as the curse of the cotton grower. The

troublesome seeds were removed in a thoroughly satisfactory manner by Whitney's gin and were cast aside as useless. Modern science, however, has found a multitude of uses for the formerly despised cotton-seed and now it is looked upon with considerably more respect.

The pure food agitators tell us that we eat it in the form of butter, olive oil, pork products, etc. However we are not in a position to affirm or deny the truth of these statements. We do know, however, that compressed air plays an important part in preparing cotton-seed oil for the market, for instance for operating formers, and for cleaning crusher rolls and separator plates,—however that is another story.

The cotton gin of to-day differs but little from the gin of Whitney's time. In outline, the gin consists of a series of circular saws mounted on a shaft and revolving between the interstices of an inclined iron grid. The seed cotton is fed at a regular rate and falls upon the grid. The saw blades beneath the grid, probably 60 or 70 in number, draw the cotton fibres through the grid, leaving the seeds behind. The seeds slide off of the grid and into a bin.

A revolving brush removes the fibres from the saw blades, whereupon they are carried by a strong blast of air through a flue and deposited upon a perforated roller. Suction is maintained on the system through an exhauster connected with the interior of this perforated roller, so the cotton is drawn to and adheres to the roller until it reaches an opening in the casing of the machine, when the strip of lint cotton emerges from the gin and is piled on the floor.

BALING THE COTTON.

After leaving the gin, the cotton is sometimes rolled into cylindrical bales, but is more usually packed into rectangular bales that vary in weight in different places from under 200 to over 700 pounds. Some form of power baler is necessary, as cotton is naturally very bulky for its weight, and it must be packed into as small a space as practicable. Three forms of presses are commonly used for this purpose, namely, steam, hydraulic and pneumatic. The baled cotton is then covered with jute bagging and secured by iron bands.

TRANSPORTATION OF COTTON.

The baled cotton is handled in different ways at the various shipping ports and transportation centres. Compressed air locomotives have been used to a certain extent for hauling cars of baled cotton. They are ideal for this purpose as the danger from sparks, which is ever present with steam and electric locomotives is entirely eliminated with the compressed air locomotive. Of course, air hoists

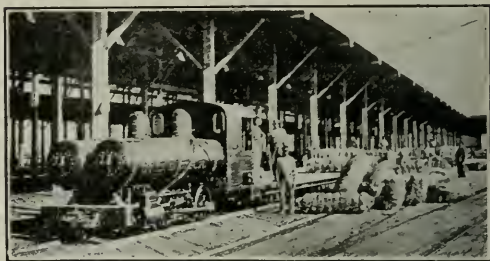


FIG. 2. A COMPRESSED AIR LOCOMOTIVE USED FOR TRANSPORTING BALED COTTON.

and lifts are also suitable for handling the individual bales.

FIRE RISK.

A cotton fire is one of the most difficult to extinguish, because the flame, once started in a bale of cotton, will continue to burn in spite of drenchings with water. The cotton is so closely compacted that the water has little opportunity to enter the interior of the bale and the fluffy nature of the cotton allows a large relative volume of air to surround the cotton fibres thus assisting combustion. The lint and cotton dust which are bound to collect where cotton is handled furnish ideal conditions for the starting of a fire. From the above, it can be readily seen that exceptional precautions must always be taken against the fire risk where cotton is handled. The history of fire fighting tells us that many of the most stubborn fires have occurred in cotton mills and warehouses.

COTTON MANUFACTURE.

We will now consider the various manufacturing processes. Generally speaking, there are three stages in the process of manufacture: (1) Spinning. (2) weaving or knitting, and (3) finishing. The first two processes are often carried out in the same mill, but

finishing differs very radically from the other processes, being largely of a chemical and physical nature, whereas the spinning and weaving are mainly mechanical operations. In following this outline of the various processes involved, it must be borne in mind that many of the steps described are omitted in certain cases, depending upon the results desired. Likewise, some of the steps may be repeated to secure further refinements or modifications may be substituted to obtain particular results.

The mill treatment comprises (1) mixing the raw cotton from several bales into a homogeneous mass, (2) removing particles of foreign matter from the cotton, (3) combing out entanglements in the fibre and arranging the fibres in parallel lines, (4) combining groups of parallel fibres, simultaneously attenuating same, (5) twisting the fibres into a thread, (6) compounding and making-up of threads, (7) weaving or knitting, and (8) various finishing processes.

SPINNING AND PRELIMINARY PROCESSES.

After the bale has been stripped by hand it enters a bale breaker whose function it is to disentangle the fibres that have been converted into hard masses, and mix the cotton. Mechanical bale breakers are of several types. Roller breakers consist of spiked rollers which reduce the stock to a fluffy mass, after which a fluted roller delivers it upon a traveling lattice which carries it to the floor of the mixing room. Hopper breakers consist of a horizontal traveling lattice which conveys the cotton and a sloping spiked one whose spikes tear away tufts of cotton and deposit them upon a second lattice for removal to the mixing room. A good mixing is considered highly desirable and at one of the largest mills in the country the practice is to take the cotton after leaving the bale breaker, and, by the aid of pneumatic pressure, pass it through two conveyor tubes each three or four hundred feet in length, to another branch of the mill. This accomplishes not only the transference of the cotton but it assists in the mixing and aging of the cotton. This tends to make the cotton uniform as to moisture content and temperature and it also releases the pressure on the fibres. A blower fan effects the transference of the cotton through the duct and the

suction of the machine at the opposite end assists in the cotton's movement.

Cotton is often left in the mixing bins for a while to season, the period varying from a few hours to a week or more.

The next process is a cleaning one, its object being to open up any remaining matted fibres and to rid the cotton of remaining impurities. The machine which accomplishes this purpose is known as a picker. In some respects it resembles the cotton gin excepting that, instead of drawing the fibres through the grid, this machine draws off tufts of cotton with great force which, by the action of an air blast, are drawn upon a grid whereupon the heavier particles of dirt fall to the bottom of the machine and lighter parts pass through the cylindrical grid. The cotton is fed into the picker upon a traveling lattice. The beaters revolve at great speed, varying from 300 to 1500 revolutions per minute, depending upon the size of the machine. An exhausting fan mounted in the picking machine maintains a strong blast of air which serves to carry the cotton at high velocity through the curved ducts of the machine and to throw out a large fraction of any remaining dirt into the interstices of gratings which line the passages. The cotton finds its way to and is deposited in patches upon the outside surfaces of two perforated zinc or wire cylinders, which form the cotton into a continuous sheet and remove further impurities. The cotton, after passing through several rollers, is formed into a lapped roll, known as a lap. This lap may be passed through one or more additional pickers and for certain classes of goods is passed through one or more scutchers, in addition. The latter resembles a picker in many respects and its operation is similar. Its chief points of difference are that it has two or three arms to act as beaters instead of a series of teeth and it is equipped with sensitive regulating devices. Its function is to continue the cleaning and form laps of uniform weight and density for the carding engine.

Some scutchers employ beaters provided with stout teeth instead of smooth blades, in which event the operation resembles combing rather than beating.

Three or four laps are usually fed simultaneously into the pickers and scutchers, thus assisting in evening up the product as it ad-

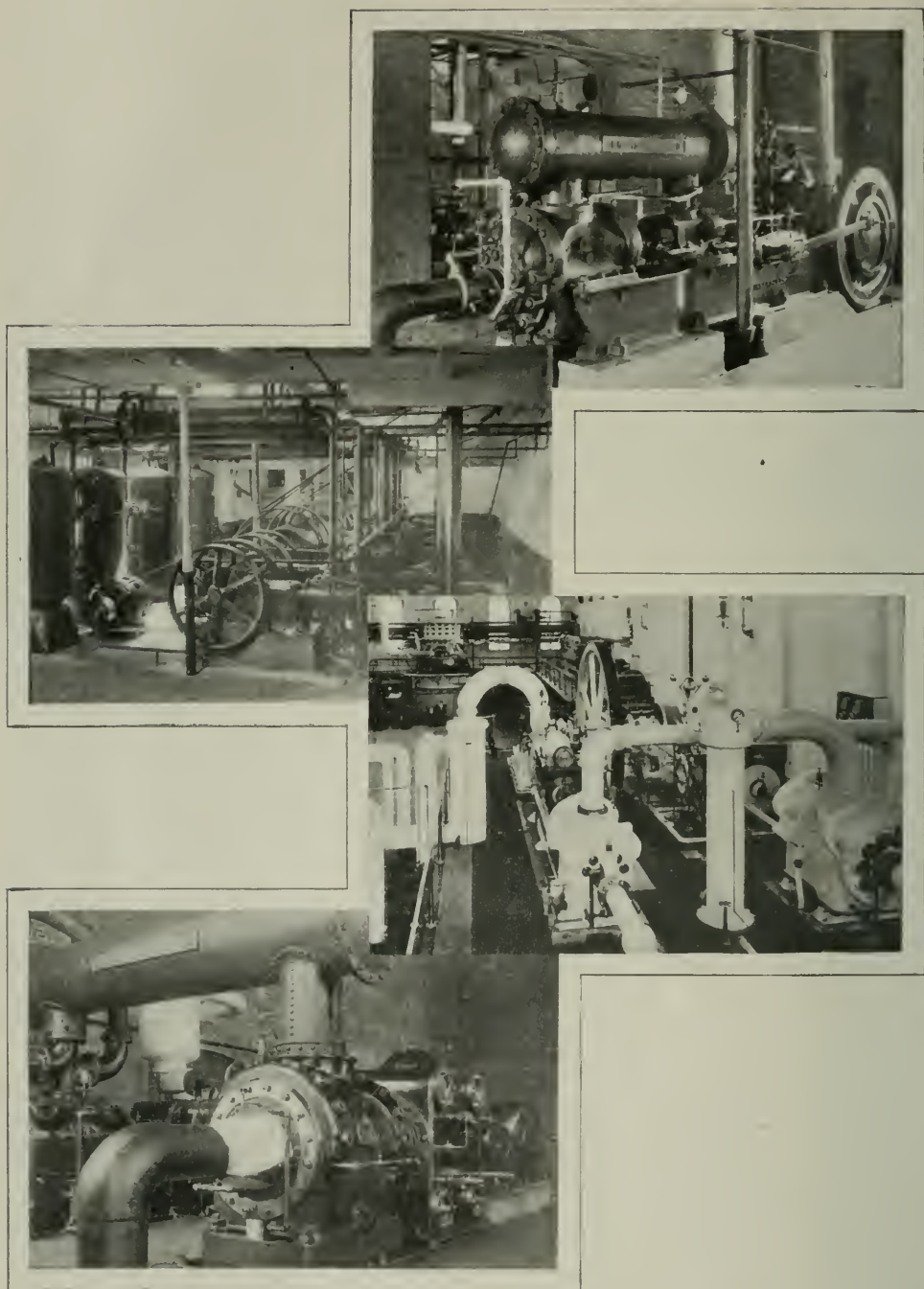


FIG. 3. TYPICAL TEXTILE MILL AIR COMPRESSOR INSTALLATIONS.

vances from stage to stage of manufacture. As a matter of fact, the cotton is usually combined and recombined hundreds of times before reaching the final stages.

The function of the carding engine or card is to arrange the fibres parallel and to remove any remaining impurities and immature fibres. A carding engine consists of three cylinders, which are covered with brush-like cards. These cards are made up of thousands of wires embedded in leather. The cotton lap is fed against the first and smallest of the cylinders, known as the taker-in. This combs out the fringe of the lap and at the same time strikes out the heaviest particles of remaining dirt. The taker-in then carries the fibres to the second and largest cylinder, which is the main cylinder. The fibres are carried around on the main cylinder passing over either a set of stationary cards or a set of moving cards, which, however, advance at a slower speed than the main cylinder. It can readily be seen that the main cylinder, constantly passing over the stationary or slowly moving cards, picks up all fibres lying crosswise and arranges them in nearly parallel lines. The slow moving cards, which are called flats, carry away the short or knotted fibres, which are taken out of the card by a revolving brush. The main cylinder eventually carries the long fibres to the third cylinder, known as the doffer, from which the fleece is stripped by a rapidly vibrating comb and fed through a funnel-like aperture into a can. The product of the card is known as a sliver and is a strand about the size of the thumb. This machine is often modified in design. Special devices are applied occasionally to remove the material that collects between the wires of the card and to grind the ends of the wires so that they will all remain of the same length.

The cotton, now greatly purified, with fibres in fairly orderly arrangement, is run through several additional machines before twisting takes place. The intermediate processes vary greatly according to the kind of yarn desired. For the finer grades of yarn a number of slivers will probably go to a sliver lapper which will combine them into a strip. In leaving the sliver lapper, the strip passes between three sets of rollers which draw it out before it leaves the machine. Several strips from the sliver lapper are combined in a ribbon lapper which delivers a strip a foot or

less in width, after attenuating the cotton as in the sliver lapper.

The ribbon laps now pass to the comber in which the cotton passes between the teeth of a comb, which removes the short fibres, known as noils. The comber noils and card stripings are usually sent to another department of the mill to be worked up into yarns of comparatively inferior grades (so called waste yarns).

The drawing frame receives the slivers from the combers and draws several slivers down to the dimensions of one. This refers to the finer grades of product. For lower and medium grades, the slivers are often taken from the carder direct to the drawing frame, omitting the intermediate steps. The slivers from the card and comber both contain the fibres in more or less irregular distribution, and it is the function of the drawing frame to improve the distribution by drawing out the fibres. The drawing is accomplished by passing between several sets of rollers under tension, the lower rollers being of fluted metal and the upper ones of leather. The front rollers revolve six to eight times as fast as the back ones, so the attenuation is great. Six to eight cans containing once-drawn slivers may be put up to a second head and similarly drawn and finally a similar number of twice-drawn slivers may be fed into a third head and again drawn, giving in all from 200 to 500 doublings.

The product of the draw frames in the form of a sliver is now delivered to a slubbing frame or slubber by which it is still further attenuated, slightly twisted and wound upon spools. Each sliver is drawn out by three pairs of rolls and as it emerges from the front pair a flyer, revolving on a spindle, carries the sliver round with it to twist the fibres. This flyer coils the twisted material upon a wooden tube or spool. The slubber product is known as a roving.

The next step is the intermediate frame, which is similar to the slubber, but has a larger number of spindles and smaller tubes. In this machine the four-fold processes of combination, attenuation, twisting and winding are effected consecutively and continuously.

The intermediate roving goes now to the roving frame, which is similar in principle to the slubber and intermediate frames, but it contains a greater number of spindles and the

tubes are smaller than in either. It draws two intermediate rovings into one, twists them and winds them upon wooden spools or paper tubes. This machine is usually the last employed to prepare cotton for spinning.

WEAVING AND KNITTING.

The single yarn is further twisted and sometimes put through other processes, as dyeing, bleaching or singeing, before being worked up into warps or filling. The various processes

fed through the bobbin. As the end of the roll of warp is reached it becomes necessary to join a new length of warp to it, and the knot-tying machine quickly and accurately finds the yarn ends and joins them to corresponding yarn ends on the new roll.

COTTON FINISHING.

The woven goods as they leave the looms may be put through one or more processes to produce any desired finish. There are many



FIG. 4. A COTTON SINGEING MACHINE IN OPERATION, EMPLOYING CRUDE OIL AND COMPRESSED AIR.

of weaving and knitting are fairly familiar. There are no direct applications of air to weaving, to our knowledge, excepting cleaning and humidifying, to be referred to later.

In connection with knitting, the Perkins Hosiery Mills of Columbus, Ga., have successfully applied compressed air to their hosiery presses, and state that this is a decided improvement over their old method. They claim that the machine does more and better work at a lower cost. Air operates through a small hydraulic cylinder, 8 by 6 inches in size, and a special valve has been designed to control the action of the press.

One machine worthy of mention is a knot-tying machine which is used in connection with the rolls of warp. The warp is rolled on wooden rollers, the width of the finished cloth, and is fed into the loom where the cloth is built up by the interweaving of the woof,

finishing processes in use, a few of which we will endeavor to describe. The simplest is bleaching, for producing white goods. Dyeing plain colors is also an important branch of finishing. Printing various designs in one or more colors is carried on to a large extent, although not as much as formerly, as the designs are often put into the goods in the weaving operations. Starching and calendering to give a glossy finish are applied to many classes of cotton goods and mercerizing is employed to give to the cotton the appearance of silk.

Most cotton goods must first be singed to remove the fuzzy particles of material extending from the surface. Ordinarily one side only is singed and that will be the finished side in the final product. Illustrations of two types of singeing machines are shown. One operates with crude oil and the other with a gas

flame. Referring to the crude oil singer, the crude oil is fed through burners under pressure. Around each oil burner is an annular opening through which compressed air enters, producing an extremely hot and long flame. The flames enter beneath three arched copper plates bent into the form of a semi-cylinder

known as a gas-mixer, before entering the pipes leading to the singer.

Air has been used in another way in connection with gas singers. The flame is so arranged that air suction deflects a portion of the flame drawing it through the openings in the cloth, thus thoroughly clearing the net or

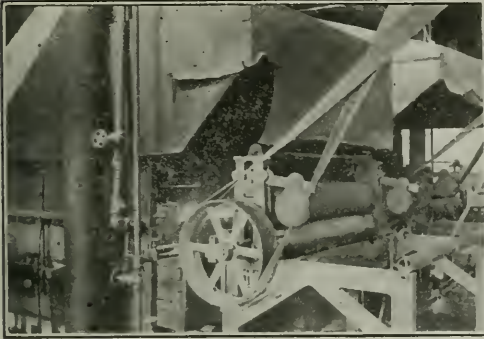


FIG. 5. BACK VIEW OF CRUDE OIL SINGER, SHOWING BURNERS TO EXTREME LEFT AND WATER TROUGH BELOW ROLLERS.

about 6 or 8 inches in diameter and 4 or 5 feet in length and with metal about an inch thick. The copper arches are embedded in cement and are spaced about two feet apart. The cloth to be singed is fed into the machine and runs through it at a speed of perhaps 75 yards per minute. The cloth is made to bear slightly on the singeing plates and, to the uninitiated, the flames shooting from the goods give the impression of destroying the cloth. However, when the singed strip is examined it is found to be in perfect condition, the burnt particles being washed out in a trough of water through which the cloth passes. The crude oil pump shown in Figure 6 has been operating for a long time on compressed air and is giving satisfactory service.

The gas singer shown in Figure 7 has five gas burners and ten rollers around which the cloth passes, later to enter a trough of water. In this particular case only two of the gas flames are burning but it can be seen that the cloth is subjected to a most thorough singeing action. These flames could be arranged in a manner similar to the crude oil burner, but in this case the gas and air are mixed in a separate motor-driven machine

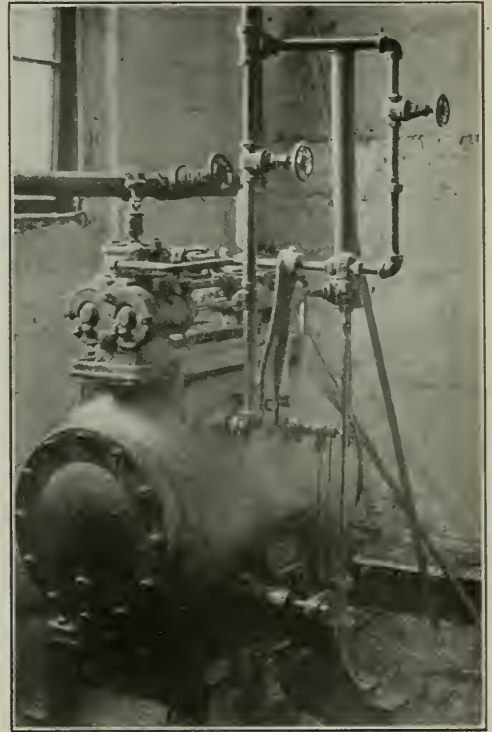


FIG. 6. CRUDE OIL PUMP, OPERATED BY COMPRESSED AIR FOR SUPPLYING THE SINGEING MACHINES.

lace of any projecting fibres and presenting a more "thready" appearance. Sometimes a singeing machine is run in connection with a shearing machine, the shear removing the longer threads as well as much of the nap or fluff.

Singed cloth that is to be made up into white goods must now be bleached in a solution of chemic, which is the cotton manufacturer's name for chloride of lime. The cloth is afterwards washed, dried by passing over cylinders heated with steam or by other means and wound on rolls.

Goods for dyeing are run over rollers



FIG. 7. A COTTON SINGEING MACHINE IN OPERATION, USING A MIXTURE OF GAS AND AIR.

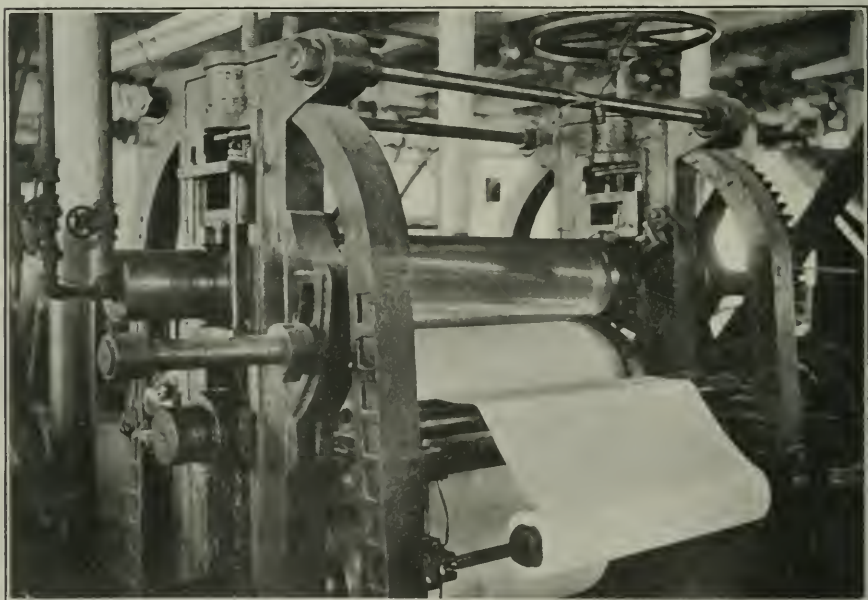


FIG. 8. A CALENDERING MACHINE IN OPERATION. THE GAS FLAME USED TO HEAT THE UPPER ROLLER IS INTENSIFIED BY MEANS OF COMPRESSED AIR.

through the dyeing solution, this operation being repeated several times.

Printed goods are handled in much the same way as a newspaper is printed on a cylinder press. The pattern is engraved or etched on copper or brass cylinders which carry the ink and transfer it to the cloth as it passes over the cylinder. It is not uncommon for a printing machine to print goods in as many as twelve separate colors.

The colors in the dyed or printed goods must be fixed—that is, made permanent. For this purpose the printed or dyed cloth is sub-

jected to the heat of steam in a large box. The metal calender rolls may be heated in various ways, as by steam and gas. The calendering machine, shown in Figure 8, utilizes compressed air to operate the gas burners which heat the rolls.

Mercerizing is a very interesting process. Its purpose is to impart to the cloth a silk-like surface. The process consists in taking the cloth from the bleachery and immersing it in a caustic alkaline solution, as potash, which shrinks the fibres and dissolves their surfaces to a certain extent. After leaving the

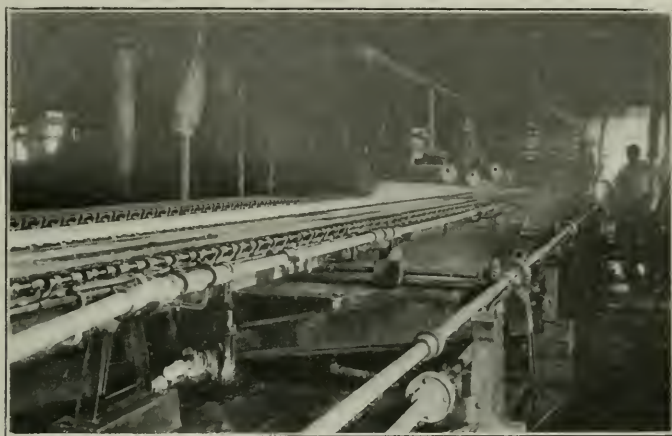


FIG. 9. A TENTERING MACHINE CARRYING A STRIP OF MERCERIZED COTTON CLOTH. PIPES ON EITHER SIDE OF THE MACHINE SUPPLY COMPRESSED AIR TO JETS FOR BLOWING AWAY SURPLUS MOISTURE.

jected to the heat of steam in a large box. This box is very large, in fact larger than many of the rooms in the plant and the steam in it is often considerably superheated. Sometimes the action of the steam develops a permanent color totally different from the initial color on the goods.

The colors fixed, the cloth is transferred to the soap house to have the surplus color and any foreign matter washed out of it.

After drying, the cloth enters a starching machine, then passes while still wet to a tentering frame, the function of which is to stretch the strip to the desired width. Often, the strip is stretched in width several inches. The cloth is dried at the same time that it is framed.

Calendering is the final operation. This is an ironing or burnishing operation which gives to the cloth, aided by the starch sizing,

alkaline solution the cloth must be passed through an acid solution to arrest and neutralize the action of the alkali. Then the cloth is washed and carried through the remaining processes.

An illustration on the following page shows a strip of cloth coming from the mercerizing solution and advancing along the ways of a tentering machine. The edges of the strip are seized by castiron clips (castiron being best suited to withstand the action of the alkaline solution) which recede transversely as they advance along the frame, thus stretching the cloth to the desired width. These clips are mounted on a chain and run in a guide, motion being imparted by a sprocket wheel which engages the chain. The sprocket is connected by belting with a steam engine. Formerly, surplus solution was removed from the clips by brushes, but great

difficulty was experienced by the brushes wearing out largely due to the caustic action of the solution. It is essential to remove the solution from the clips before they grip the cloth or a mark will be sure to be made on the cloth. The difficulty was thoroughly overcome by blowing the liquid from the clips with air jets. Nine air jets, in sets of three, are arranged on either side of the tentering machine and direct blasts of air at an angle of about 45 degrees against the clips. The air is under about 25 or 30 pounds pressure. This novel application of compressed air has proved thoroughly satisfactory and is employed on several machines in the works in which the

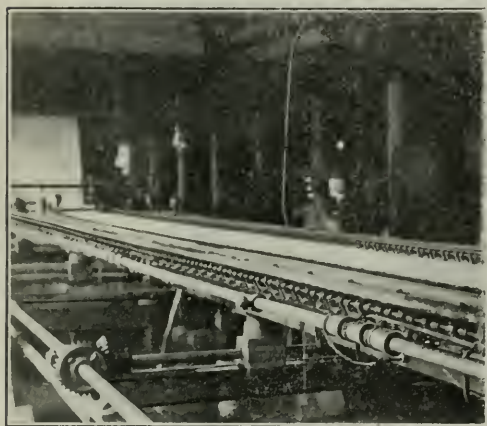


FIG. 10. A TENTERING MACHINE WITH MERCERIZED COTTON STRIP ADVANCING. THE AIR PIPE AND JETS ARE SHOWN IN THE FOREGROUND.

photograph was taken. Fig. 9 shows plainly the shower of warm water for removing the surplus caustic, after which the cloth is fed through an acidified solution. The tentering machine automatically seizes the cloth at the beginning of its travel and releases it at the end.

Compressed air has been further applied in finishing works for agitating, elevating and transferring dyes and solutions and for cleaning presses, slashers and other machines by the air jet.

HUMIDIFYING.

Throughout all the operations of cotton spinning, weaving and knitting it is desirable, in fact almost necessary, to keep the air in the factory at a uniform and fairly high de-

gree of humidity. Artificial humidifiers have made it possible to operate cotton mills successfully in other sections of the country than those originally supposed to be particularly adapted to cotton manufacture. Even in comparatively humid England at least one-half of the mills use some form of artificial humidification.

Cotton is composed of myriads of very close filaments held together by waxy or gummy substances. Too dry or too hot atmospheric conditions cause the filaments to separate, filling the air with particles of dust and lint. This condition is highly objectionable as it increases the difficulty of manufacture, increases the percentage of waste, makes the working conditions much more uncomfortable for the workers, increases the cost of cleaning and increases the fire risk. The rapidly moving machinery and the static effect of driving belts increase the circulation of dust and lint. The static effect is entirely eliminated with high degrees of humidity. There can be no doubt that adequate humidity actually increases the output by strengthening the yarn and it improves the product by causing the fibres to engage together more closely and by giving greater elasticity to the product.

In the early days of cotton manufacture, floors were sprinkled and troughs of water kept near the machines. Now practically every progressive mill in this country has a humidifying equipment of some sort. Several types of humidifiers are in general use. Vapor pots are to be found in some of the older mills but they have many objectionable features. In the first place they heat as well as humidify, for they add a large volume of steam to the air. This is not only an expensive procedure but it adds to the discomfort of the operators in warm weather. Most modern plants have an equipment of one or both of two classes which may be termed the local distribution type and the air conditioning type.

Each of these has its advocates, but local distribution is more generally used, and to this system compressed air has been successfully adapted. Many humidifier systems use water under pressure, and are characterized by bulky metallic casings and systems of drain pipes, all of which require frequent cleaning. Compressed air humidifiers on the other hand, require no drainage system, as all the water delivered is completely evaporated. The water

used is supplied by gravity from small tanks at the level of the supply pipes, which are provided with safety overflows, and the danger of damage to stock and machinery from overflow and leakage is thus obviated. The pipes, being small, occupy so little room that they can be installed in low posted rooms without inconvenience.

heads are located. Parallel with these branch air lines are water lines. These are run dead level.

Water is supplied through a small covered, float-controlled tank. This tank is equipped with overflow pipe, draw-off pipe, filter, etc., and is covered to keep out dust and lint.

One of these tanks will supply from sixty



FIG. II. TURBO HUMIDIFIERS IN THE PLANT OF THE FULD AND HATCH KNITTING CO., COHOES, N. Y. NOTE THE STRAIGHT LINE METHOD OF DISTRIBUTION.

For lack of space we will restrict our description to the "Turbo" humidifier, which is a representative humidifier of the type using compressed air. This device was invented by Mr. Albert W. Thompson, Mechanical Superintendent of the Amoskeag Mfg. Co., Manchester, N. H., which is one of the largest textile manufacturing plants in the world. This humidifier is manufactured by the G. M. Parks Co., of Fitchburg, Mass. Mr. Thompson was one of the first engineers to appreciate the applicability of compressed air to textile manufacturing processes and the present extensive use of compressed air in cotton mills is largely due to his pioneer work in this field.

Describing the "Turbo" humidifier system, air is supplied through a main pipe to the several branch lines in which the humidifying

to seventy heads, but in large rooms the best practice is to divide the system into two, three or four separate sections. The tanks may be located in toilet rooms, or other convenient, accessible places. The water line, controlled by the overflow pipe, is located one and one-half inches below the centre line of the head.

It is absolutely impossible for water to overflow from the heads on floors, machinery, stock, etc., for when the air is shut off there is no power to lift the water up to and into the head; when the water is shut off the air has no water to lift—hence no damage either way.

Air is supplied at about 65 pounds pressure at the orifice of the humidifier and, passing tangentially over the end of the water nozzle, produces a partial vacuum, drawing the water up the supply pipe and projecting it into the

air in the form of a fine spray. In several mills visited by the writer the air pressure in the receiver did not exceed 35 or 40 pounds, but no difficulty was experienced with these reduced pressures.

The Turbo valve is located under each head, so that any may be shut down without interfering with the others. Simply shutting off the air shuts down the head. The power required is not considerable, and where the

of space, according to the processes, the department and local conditions.

It is apparent that if the atmosphere is over-saturated, it is harmful to health; but properly humidified air acts in a manner quite the opposite.

A properly humidified air will always be more healthful than a hot, dry atmosphere, and decidedly more so than one containing dust and lint.



FIG. 12. TURBO HUMIDIFIERS IN THE WEAVING ROOM OF THE CHICOPEE MFG. CO., CHICOPEE FALLS, MASS. NOTE THE RING METHOD OF DISTRIBUTION.

exhaust steam can be utilized for heating feed water, heating mill, etc., the independent steam driven compressor will furnish this power at a negligible cost.

The power load is proportional to the number of heads in operation or the actual work being done by each head. If at times half the heads will do the work—as they will under certain atmospheric conditions—the operating cost is cut one-half.

The spray is so fine it will not settle on floors or shafting, belts or machinery.

In capacity, based on cubic contents which one head will supply, each "Turbo" humidifier will serve from 6,000 to 20,000 cubic feet

Cool, damp air has a tendency to fall. In settling it will prevent the formation of dust and lint.

The most desirable system of artificial humidification is one that can be started before the mill starts. This brings about the proper conditions of humidity by the time the operatives arrive. A system that depends on mill power will cause the humidity to "lag" until the proper conditions are brought about. This is especially marked on the morning after a holiday, or on cold, dry mornings in winter.

Live steam introduced into the mill atmosphere is always under control; but since it increases the temperature it tends to defeat its own object. The increased temperature

continually calls for larger amounts of moisture to maintain the desired relative humidity. Moreover, it has been found to be detrimental to health; a source of discomfort; inordinately expensive, and in England, we understand, is prohibited by law.

The expansion of the air combined with the

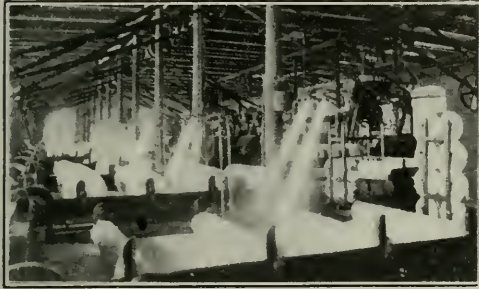


FIG. 13. MOISTENING BLEACHED AND COLORED COTTON LAPS ON FINISHER PICKERS.

evaporation of the water in the "Turbo" humidifier absorbs considerable heat from the atmosphere and actually reduces the temperature of the room from a fraction of a degree to several degrees.

This is greatly appreciated by the workers in the warm season. In cold weather it is customary in some mills to heat the water with steam coils inserted in the supply tanks, before evaporating it.

MOISTENING STOCK.

Figure 13 illustrates a useful modification of air humidifiers for the purposes of stock moistening, for which a special head is used to give a coarser spray than that produced by the standard humidifiers. These are often of great use in carding colored and bleached cotton, and the cut referred to shows a row of finisher pickers on which the back laps are moistened by humidifiers.

VENTILATION.

Efficient ventilation is highly desirable in the cotton mill, not only for the health and comfort of the operatives but also to remove the minute particles of dust which will be given off to some extent even in the best equipped mill. Exhauster fans are used largely for this purpose and many mills are equipped with air conditioning apparatus which supplies fresh air, heated and humidified before being introduced.

CLEANING.

Cleaning has always been a troublesome problem in the cotton mill, and its satisfactory solution was not found until compressed air was applied. Many attempts were made to apply vacuum cleaning, which has met with such marked success in domestic and some industrial operations, but it cannot successfully clean in and around cotton machinery, as the air jet does. The cleaning feature has been found to be an additional advantage with the "Turbo" humidifying system. Outlets may be left at convenient places, so that hose may be attached, and compressed air used for cleaning machinery or in inaccessible places. This is found to be very advantageous in plants where it has been adopted.

Tentering machines, stock dryers, and machines of this type usually require from one to two hours per week for cleaning. These may be more thoroughly cleaned in fifteen to twenty minutes by the use of air nozzles than is possible by hand.

Nappers requiring a half-hour's stoppage per day for hand cleaning may be cleaned in from five to ten minutes per day by the use of compressed air.

Ring spinning frames, usually requiring from one hour to an hour and a half per week stop-



FIG. 14. CLEANING MAIN BEARINGS AND UNDERWORK OF A RING SPINNING FRAME.

page for hand cleaning, may be cleaned in from twenty to thirty minutes a week—about two per cent. increase in production.

As an instance of what may be done, we cite an actual case of a room containing 50,000 ring spindles on 26's yarn, where the number of hands required in cleaning and sweeping was reduced from fourteen to nine after air-cleaning service was installed.

A weaver can clean a loom in less than two minutes with a nozzle more thoroughly than in twenty minutes by brush. This cleaning may be applied as often as desired, resulting in an improved product, and more of it. Whenever the warp runs out, the cleaning nozzle may be brought into play, and all parts of the loom can then be subjected to a still more thorough cleaning.

Insurance men affirm that rooms cleaned by compressed air are found much freer from the conditions inviting the starting and the spreading of fires.

Pulleys, shafting, and ceilings also may be cleaned by air applied through a light brass tube in a hollow wooden pole.

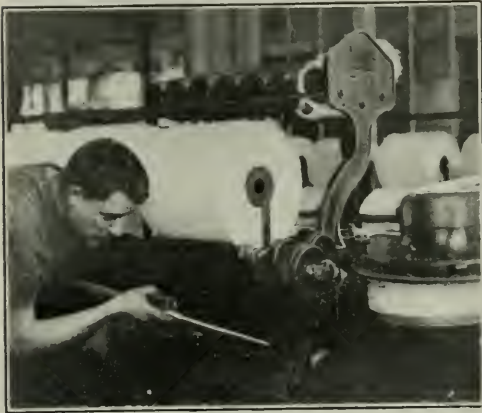


FIG. 15. GETTING INTO THE CORNERS OF A COTTON MACHINE WITH THE AIR NOZZLE.

Less stoppage is necessary than where the overhead cleaning is done with brooms and brushes, as the work is done in much less time and very much more thoroughly.

The lint dislodged by the nozzles is so heavy that it settles at once to the floor. The operator soon learns to keep the point of the cleaning nozzle depressed, and no trouble then results.

The nozzle used for air-cleaning service has a small stop valve, controlled by the thumb of the operator, and an extension of about 15 inches of quarter-inch pipe reduced to a very small opening at the tip. This nozzle consumes from twelve to fifteen feet of air per minute, which corresponds to less than two horsepower. Care must be taken to have air for cleaning purposes free from moisture.

For cleaning motors and other electrical machinery when exposed to the dust and the lint inseparable from textile mills, air cleaning is an essential rather than a convenience and is widely used for this purpose.

In some mills the operators clean their own machines as occasion requires. In others, a regular cleaning staff is maintained, whose duty it is to go through the various departments systematically. Generally the walls and ceilings are cleaned down by extra hands after the mill has shut down, the looms, spinning frames, etc., being covered with cloths.

FIRE EXTINGUISHING APPARATUS.

Many cotton mills make a practice of keeping the automatic fire extinguisher pipes filled with air. The extinguisher system is connected with the air system and the extinguisher pipes are (or should be) inspected daily, to make sure that they are filled with air. The object of this arrangement is to avoid the possibility of the pipes becoming frozen and inoperative and also to prevent leakage on the stock should a pipe or head spring a leak. Of course, in the event of a fire, the air would have to be expelled from the pipe before the water could become effective but this would require a very short time. Some cotton mills use compressed air only in the store house extinguishers where there is the most danger from the possibility of freezing.

THE AIR LIFT FOR WATER SUPPLY.

Air has been used extensively in various industries for pumping water by means of the air lift. Cotton mills require an abundant and reliable water supply and for this purpose the air lift is often the ideal equipment. It is peculiarly adapted for lifting water from driven wells, especially those of great depth. Where an air compressor is already installed to supply air for other operations, as is the case in most cotton mills, an air lift system obviously has additional advantages. The air lift is characterized by extreme simplicity as there are no moving parts whatever, simply the water supply pipe and the air pipe which carries the air to the bottom of the water supply pipe mixing with the water and raising it to the surface. The water from an air lift system is as pure as the source of supply, and in some cases it is actually purer as the aeration of water always results in purification. The water is also slightly cooled due to the ex-

pansion of the air. No attention is required and there can be no trouble from wear and leakage due to sand or grit in the water. Air lifts are suitable for very deep wells and for very high lifts.

The air lift system of water supply at the

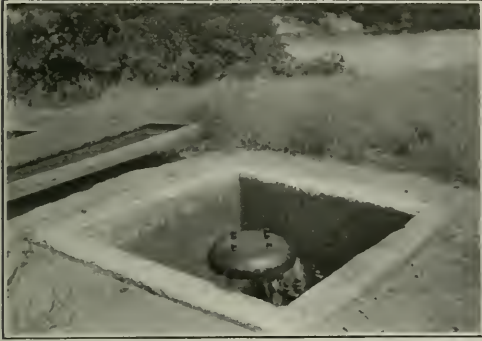


FIG. 16. ONE OF THE SEVENTEEN WELLS AT THE PLANT OF THE U. S. FINISHING CO., PAWTUCKET, R. I.

United States Finishing Company's plant at Pawtucket, R. I., is a typical one and for that reason a brief description of it will be given. The water supply from a pond located near the works and fed by a spring was found to be insufficient for the Company's needs, so

seventeen wells were sunk varying in depth from 117 to 300 feet. One of these wells is "dead," leaving sixteen in operation. The principal use is in the bleach house, which consumes large volumes of water. In the daily run of eleven hours, the air lift supplies 2,000,000 or more gallons of water to the works.

The air lift is of the Harris "Twentieth Century" type and the compressor is an Ingersoll-Rand Class "OC" Corliss steam driven, two-stage machine, with both steam and air cylinders compounded. The stroke is 24 inches; the low pressure steam cylinder is 30 inches in diameter and the low pressure air cylinder is $27\frac{1}{4}$ inches diameter. The high pressure steam cylinder is 18 inches diameter and the high pressure air cylinder is $16\frac{1}{4}$ in. diameter. An intercooler is mounted above and between the two air cylinders.

The compressed air is carried directly to a receiver in the yard. A two-inch main conducts the air from the receiver to the works and a six-inch wrought iron main carries the air to the wells. There are two drains in the receiver and, as all the air lines drain back to the receiver, there is never any trouble from condensed moisture if the drains are opened two or three times a week.

A main valve in the air line near the wells controls all of them. Branch air lines $1\frac{1}{4}$



FIG. 17. THE OVERFLOW POND AT U. S. FINISHING COMPANY'S PLANT, PAWTUCKET, R. I. THE COMPRESSOR HOUSE ADJOINS THE CHIMNEY IN THE BACKGROUND.

in. lead from the main to the individual wells. The water pipes in the wells vary in diameter from 2 to 4½ inches. The water main leading to the bleachery is 12 inches in diameter. As the water is lifted from the well, it strikes the under side of a mushroom-shaped discharge plate, known as a deflector head, and falls into a concrete pit, which is covered over with a wooden cover.

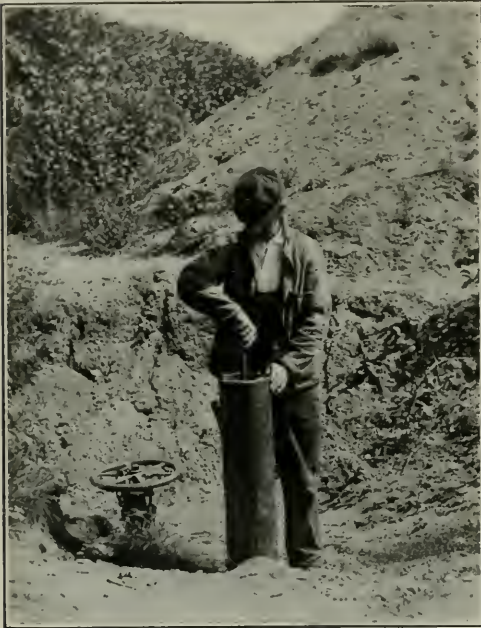


FIG. 18. OPERATING THE VALVE CONTROLLING AIR SUPPLY TO THE WELLS, U. S. FINISHING CO., PAWTUCKET, R. I. WATER OVERFLOW VALVE ALSO SHOWN.

When the full supply of water from the wells is not needed in the bleachery, the excess water overflows into the storage pond.

A pressure of 75 pounds per square inch is maintained in the air receiver and this is sufficient to operate the wells satisfactorily, although the pressure has to be increased to 90 or 100 pounds to start the wells running.

COMPRESSED AIR IN MILL CONSTRUCTION.

In mill construction, pneumatic service is invaluable to the manufacturer conducting his own building department. Or, if the plant is being built under contract, the use of compressed air by the contractor may be made valuable to the owner in reducing the initial cost of construction.

A prominent cotton mill engineer recently stated that "the economy secured by the use of pneumatic tools in the construction of a 25,000 spindle mill would pay the entire cost of purchase and installation for a compressed air plant of sufficient capacity to be subsequently used for cleaning and humidifying for the entire mill."

Pneumatic wood-boring tools may be used advantageously in mill construction. With such a machine, one man can easily fit the timbers for anchors and dogs and do work which would require at least two men with hand tools.

Boring tools of the same kind may be later used for hanging shafting. The hangers are usually supported by two three-quarter inch



FIG. 19. A PORTABLE MILL DERRICK OPERATED WITH AN "IMPERIAL" PNEUMATIC MOTOR USED IN COTTON MILL CONSTRUCTION.

lag bolts. The holes are bored with a five-eighths inch auger. The lag bolts are screwed home by means of a blind nut which fits a socket on the spindle of the boring machine.

In this manner a gang of seven men may put up from 80 to 100 hangers in nine hours.

Another convenient use for pneumatic service in mill construction is a portable mill derrick mounted on trucks to set columns and timbers. A derrick fitted with a pneumatic motor, does this work very quickly. With a hand derrick, a gang of ten men could set about five timbers an hour. With a pneumatic derrick, as many as twenty have been set in an hour, and a rate of twelve to fifteen may easily be maintained.

This apparatus is also convenient for hoisting bundles of plank from the floor last com-

(Continued Page 7006.)

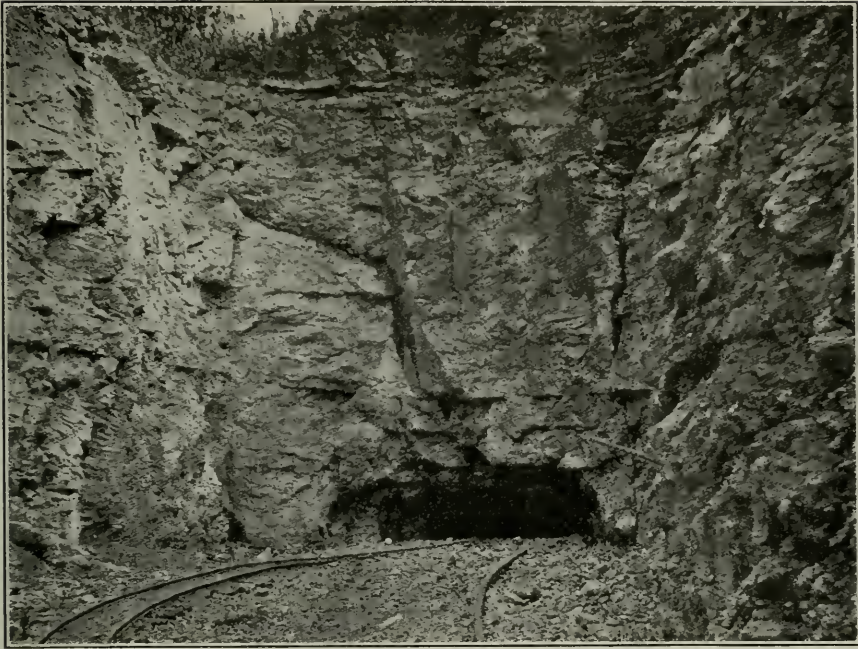


FIG. 1. HEADING AT GRADE. NORTH PORTAL BLOUNT TUNNEL.

THE BLOUNT AND THE MT. HAYDEN TUNNELS

Some interesting engineering operations are usually involved in the relocating of portions of established railroad lines. The new layout of the Louisville & Nashville Railroad between Blount Springs and New Castle in northern Alabama, on the main line between Birmingham and Cincinnati, shortens the mileage, obtains better grades and gets rid of some bad curves. There are here located two tunnels known as the Blount and the Mt. Hayden, and these, although so near together that one power plant suffices for the construction of both, are quite different as to the material encountered. The finished section of the tunnels, double track, is $27\frac{1}{2}$ by 33 ft., the former being 1,015 ft. long and the latter 2,100 ft.

THE BLOUNT TUNNEL.

The Blount tunnel is through hard limestone and black flint, so solid and homogeneous that no lining is required, and it is driven by means of a bottom heading. The Mount Hayden, the longer tunnel, is through a constantly changing material, hard in places and at others so soft as to afford little support for the bracing

This is being driven with a top heading, and it will have to be lined practically all through.

Fig. 1 shows the heading at grade at the north portal of the Blount tunnel. The heading was first driven all through the tunnel to a height of 7 ft. above subgrade and in general to the full width of the double track tunnel. Six $3\frac{1}{4}$ -in. Ingersoll-Rand drills were used, mounted on columns, with two men to each drill. There were 30 holes drilled to each round to a depth of 12 ft., starting at $3\frac{1}{4}$ in. and bottoming at 2 in. The feed of the drills called for changes of steel for each 24 in., but it sometimes took from two to six steels to do the 24 inches of depth.

The frequent and constant renewing of the steels as required promoted a keen appreciation of the No. 5 Leyner Drill Sharpener employed on the work. About 400 lb. of 60% Forcite $1\frac{1}{4}$ -in. was used for blasting each round, electrically fired. The heading was driven through in 130 working days, employing two shifts.

While this heading was being driven from the north end the south approach cut was being opened, and then a narrow gage track was laid all through the tunnel. Beginning at the south portal for the removal of the

top, section holes for blasting are driven upward at an angle of about 30 degrees with the vertical, the angle being toward the south portal. From side to side of the tunnel there are six of these holes in each row, and the rows are about 7 ft. apart. All of the holes in a row are charged and set off simultaneously, the loosened rock falling to the floor of the tunnel, where it is picked up by a Marion 41 shovel operated by compressed air, loaded on side-dump cars on the narrow-gage track and hauled out by a dinky to be dumped into permanent embankment beyond the cut. By keeping the shovel the right distance behind the blasting the top of the loosened pile is kept just high enough to allow laborers on top of it to scale off the loose rock from the roof of the enlarged tunnel.

The longest holes are 22 ft. deep, and as the feed of the drill is 2 ft., eleven lengths of steel are required. As the free space below is only 7 ft. the longer steels have to be sprung and coaxed to get them in. The steel is 1 in. diameter and requires to be of high grade to stand the springing and the jar of the hard rock, the Leyner drill sharpener encouraging frequent renewals of the bits and the maintenance of the gage so that there is little time lost by the sticking of the drills.

THE MT. HAYDEN TUNNEL.

The Hayden Mountain tunnel is being driven from both ends with top headings. The north-approach cut is small and the portal was easily reached. That at the south end, however, is $\frac{3}{4}$ mile long and involves more than 200,000 cu. yd. In order to get to work at the portal, an incline at about 30 deg. with the horizontal was driven. Up to May 1 the south heading had advanced about 1000 ft. and the north one 400 ft., leaving 700 ft. between the two.

The material appears to change in character about every 200 ft. In some places it is hard and solid and requires no temporary bracing; at other points it is so soft that difficulty is experienced in getting adequate support for the bracing. Water drips abundantly from the roof of the heading at some points, while at others it is entirely dry. One of the worst spots encountered was at the north portal. Here the material is soft and wet, and that above gave indications of a desire to slide longitudinally into the cut. The bottom section at the portal was, therefore, excavated and

the portal was built at once about 50 ft. farther out than was originally intended. In order to get sufficient bearing for the concrete lining in the soft material, footings 6 ft. wide were laid. The lining has been placed a short distance in, and it is believed that the tunnel and cut are now sufficiently protected against any slide.

At this end the material is being hauled out in cars by mules and dumped off the end of the fill near by. At the other or south end, however, the situation is much more complex. The line as located from the tunnel south follows a narrow and winding ravine, and the subgrade will, when the cut is finished, be from 35 to 40 ft. below the original bottom of the ravine for a distance of $\frac{1}{2}$ mile or more. Thus far the cut has been taken out to about half its final depth only, the spoil being used up in the embankments beyond, the quantities of which exceed those of the short cuts between them. Most of the remainder of the material will have to be hauled 3 miles to a 250,000-cu. yd. embankment. This embankment, which will be 3000 ft. long and up to 52 ft. high, is notable in that it will be along a ridge and will require absolutely no opening for drainage. The approach cut, which is hard sandstone, is being taken out with a Marion 60 steam shovel, and hauled away by narrow-gage dinkies in eight-wheeled 8-yd. side dump cars of the Oliver and Western makes.

In order to get started on the south end of the tunnel before the cut could be opened the incline previously mentioned was opened up and a narrow-gage track laid on it. The track was carried on up the hillside by means of a double switchback. Loaded cars are hauled out of the tunnel and up the two inclines by cables operated by a stationary engine, and the material is wasted off a trestle at the high level, the empty cars returning by gravity.

COMPRESSOR PLANT.

The compressor plant for both tunnels, comprising four straight line machines with a free air capacity of 5,000 cu. ft. per min., is located along the present line of the railroad at tunnel. The air is piped from the plant to Blount Springs, about 1 mile from Blount the Blount tunnel and from there to the Hayden Mountain tunnel, and some distance beyond (4 miles in all), supplying the drills in the tunnels and the cuts, the drill sharpener,



FIG. 2. SOUTH PORTAL BLOUNT TUNNEL FULL SIZE.

and the Marion 41 shovel in the Blount tunnel. From the compressor plant to the first tunnel an 8-in. cast-iron pipe is used; from the first to the second, a 6-in., and beyond that a 4-in. The pipe is laid on or near the surface of the ground, and several expansion joints have been placed in the long straight stretches. Such a joint is made by an offset in the pipe line, the gap being closed by an elbow turned upward at each of the unconnected ends of the main pipe, and a short straight length with an inverted elbow at each end engaging the first two elbows. The short length is above the main pipe line and about at right angles thereto, changing its direction as the main line pushes together or pulls apart. The arrangement of plant and pipe line has worked very successfully, with little loss of pressure for the 4 miles.

All of this work is being done by Messrs. Thrasher & Gunter, contractors, of Knoxville, Tenn., under the general supervision of Mr. John Howe Peyton, chief engineer of construction of the Louisville & Nashville Railroad, and under the more immediate direction of Mr. T. Q. Harrison, engineer of construction of the South & North Alabama Railroad, which is the corporate name of the subsidiary company handling the work. Mr. Asher Dole is resident engineer on the work.

STOPPING DRILLS*

BY ALBERT E. HALL.

A stopper is cheaper to operate, since it can be handled by one man instead of two, as required on a large machine. In some cases a helper is assigned to two or three stoppers, but as a rule this is not advisable. In addition, the use of stoppers permits a large proportion of the total time to be spent in actual drilling. With a big drill, much time is consumed in setting up after a blast or after moving to a new working place; with a stopper, on the other hand, the preparations for drilling are simple. As a rule, a stopper can be rigged up and set to work 30 to 40 minutes earlier than a big drill. One disadvantage of the stopper, when used for shrinkage stopping, is its tendency to create a large amount of shattered and partly loosened rock on the roof and walls of the working place. The men must first scale off this loose ground, which takes from 30 minutes to an hour. With a sufficient number of working places, however, this scaling can be done by a special gang, while the machine men are drilling in a previously scaled place.

As a result of the extra time applicable to drilling, and also of the more rapid drilling, stoppers make an average of 30 to 40 linear feet

*Columbia School of Mines Quarterly.

of hole per shift, while a large drill will make 20 to 30 ft. As a rule, stopers work on a bench in the back. When necessary, a bench is created by taking out a diamond cut, and is then followed across the stope. The holes are made about 6 ft. deep. The amount of powder used (40% dynamite) as computed from several groups of holes, averages 0.63 lb. per cubic yard of ore. The amount of air consumed by a stoper is estimated to be about two-thirds of that used by the largest drills.

Some workmen object to the stopers on the ground that stoppages for small repairs are too frequent. It is true that the dust, which is a disadvantage in itself, from the runner's standpoint, sometimes clogs the valve and prevents the extension leg or standard from working properly, but only a few minutes are needed to clean out the valve, and if a screen or a bit of waste be put into the hose, this trouble is almost eliminated. Water sprays can also be used. On the basis of total repair bills, the stopers do not compare unfavorably with the larger machines.

In many places it is impracticable to use a stoper, and a big drill becomes necessary; for example, in hard rock, where the light drill makes little or no headway; but in shrinkage stoping the smaller machine does excellent work. The stoper has one advantage which is probably realized fully only by the men working underground: this relates to the matter of block-holing. Where the muck is being drawn off through chutes, the size must be fairly small so as not to block the chute and so hinder tramping and hoisting. With small stoping drills, the ground is generally broken small enough to pass readily through chutes, and very little block-holing is required. With large machines, on the other hand, considerable block-holing is necessary.

A BONUS SYSTEM FOR EFFICIENCY ENGINEERS

John Archibald was an efficiency engineer—at least that is what he called himself. There is no question but that he was very efficient in making his presence known whenever he was around. He made a business of placing old-fashioned plants upon a basis where they could double their dividends—at least that is what he said he did, and on the strength of what he said about himself, he was called into consultation by the owners of the

Smith & Brown Co., which has done a profitable business for the last twenty-five years.

One sunny morning Mr. Archibald appeared at the Smith & Brown plant and began taking notes of the very inefficient methods that they were using; and he was quite frank about letting them know that he could see opportunities for improvement right and left. He studied the conditions for a week or so and then he made his report, which was to the effect that he saw chances for decreasing costs to the extent of \$40,000 or \$45,000 a year. He also reported that this improvement could be made if he were hired as efficiency expert and given two assistants of ordinary training and intelligence. He further intimated that his services would be worth \$5,000 a year and, as his assistants could be hired for very little money, a saving of at least \$40,000 a year could be accomplished with an almost negligible initial expense. This report ought to have pleased the Smith & Brown Co., and it undoubtedly did, but the prospects of the coming prosperity somehow burst so suddenly upon the owners that they were unable to decide right away as to what to do. They agreed, however, to write to Mr. Archibald within a few days stating their intentions. In a few days Mr. Archibald received the following letter from Mr. J. P. Smith, the President of the Smith & Brown Co.:

MR. JOHN ARCHIBALD,

24 Blank St., New York City.

DEAR SIR: We have carefully considered your report regarding the possibilities for increased efficiency in our plant. We think, however, that the compensation which you expect for your services is entirely too modest and is not commensurate with the great saving that your knowledge and ability would accomplish in our plant. We therefore propose that instead of paying you a fixed salary of \$5,000 a year, as stated in your memorandum, we share with you the entire resulting savings of the first year, after the system which you will install has been put into operation, you receiving one-half of this saving. We think that this arrangement will be entirely agreeable to you and expect to hear from you at an early date.

Yours very truly,

J. P. SMITH, Pres.

It has always seemed very peculiar to Mr. Smith that he never heard from Mr. Archibald.—*Machinery*.

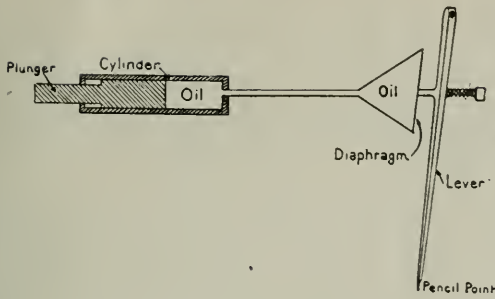


FIG. 1.

ROCK DRILL TESTING AT NORTH STAR MINE

BY ROBERT H. BEDFORD AND WILLIAM HAGUE.*

The following article, describing efforts made to throw light on some of the dark spots connected with rock-drills and drilling, may prove interesting to those with whom the drilling problem is relatively important. At the North Star mine, Grass Valley, California, where these tests have been carried on, the ore is a narrow vein of quartz between walls of tough diabase in the upper, and no less tough granodiorite in the lower levels. The

amount expended last year at this mine upon drilling, namely, for labor, power, repairs, lubricants, hose, and tool sharpening, was 20% of all outlays made. It is, therefore, of the utmost importance that the drills shall be kept in the best repair. The work of collecting details of drill-repair data started about two years ago. Early in the investigation it was found that drills which sounded all right when run against a block in the repair shop, frequently did but poor work underground. A great part of the loss in the mine was directly due to inferior condition of machines. There was needed some testing device which would give reliable information concerning the condition of a drill. W. D. Paynter, the "drill doctor," accordingly set himself to the task of devising such a machine.

THE FIRST TESTER.

The tester as originally constructed consisted of a plunger, cylinder, and diaphragm, the system being filled with oil. This is shown in Fig. 1.

The blow of the drill, through the plunger and oil, expends its energy in distending the diaphragm. The number and magnitude of these movements of the diaphragm, when suitably recorded, give a graph of the work done by a drill. The magnitude of each diaphragm

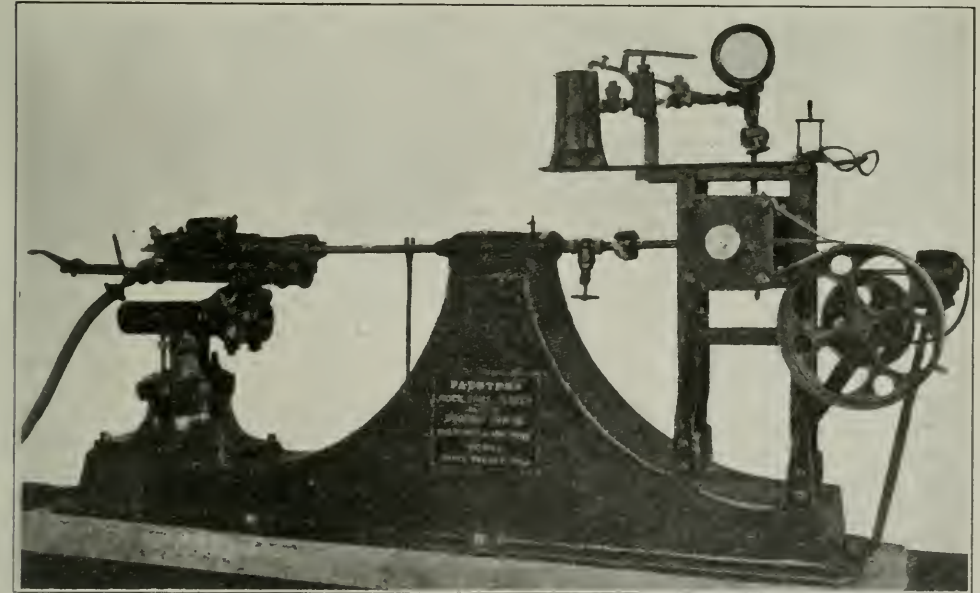


FIG. 2.

*Acknowledgment is made also to the engineering staff of the North Star Mine.

movement is measured by a lever, so arranged as to record the displacement in an amplified form upon a strip of paper fastened to the periphery of a rotating drum. The graph so obtained, in addition to showing the number of blows per minute and the strength of each blow, shows any abnormal action of the drill. Results obtained with this crude apparatus were encouraging enough to warrant the building of a more elaborate and precise machine, the essential features of which have been patented by Mr. Paynter. This machine is able to test both air-feed stopers and reciprocating drills.

Fig. 2 is a half-tone of the perfected machine, with a feed-screw machine in place to be tested.

Fig. 3 is the card of an air-feed stoper, No. 205. This card was obtained in the following manner. The drum was rotated with no pressure on the system, the resultant trace is marked "O air pressure." Air was then admitted to the feed barrel and the drum rotated to give the trace marked "feed barrel pressure." With the drum turning, the drill was started, giving the trace marked *A B C*, etc. The length of the line *A B* represents the magnitude of the kinetic energy of the blow delivered by the hammer. The reaction of the diaphragm in assuming its normal position is shown by the line *B C*. That the strength of the blow might be given in foot pounds, the tester was calibrated by means of a pendulum.

Fig. 4 is a card obtained from another machine of the same type but showing a small intermediate "reactionary" blow, which has not as yet been explained. The drilling speed in hard rock should be compared to that given with Fig. 5.

Fig. 5 is a card of a machine in poor repair. It is of interest because it plainly shows a great departure from the graphs obtained from good machines of which Fig. 3 and 4 are examples. The great variation in the actual drilling speed obtained by the machines shown in Fig. 4 and 5 in hard rock confirms what the tester indicates by the relative strength of blow.

Below are given in tabulated form the results of tests on various machines. Unless otherwise stated, the machines tested are air-feed stopers of various construction.

TABLE I.—MACHINE NO. 85,042.

Gage	Blows per min.	Ft.-lb. per blow,
98	2280	29
90	2244	27
85	2208	25
74	2100	21
66	2016	20

It should be noted that the strength of blow seems to be more affected than the number of blows by the gage pressure. Thus, in this instance, a 32% drop in pressure caused a 31% drop in the strength of blow, but only a 12% drop in the blows per minute. This has been the case with every type of machine so far tested.

Table II shows the effect of various gage pressures upon drilling speed in hard rock.

TABLE II.

Machine.	Gage pressure.	Blows per min.	Ft.-lb. per blow.	Ft. drilled per minute.	Remarks.
No. 501..	95	1210	39	0.36	Sharp steel.
..	80	1170	34	0.34	
..	70	1115	27	0.19	
No. 501..	90	1200	38	0.26	Same steel as
..	80	1170	34	0.23	used in first
..	70	1115	27	0.14	test.
No. 201..	95	1190	39	0.20	
..	80	1150	34	0.20	
..	70	1100	27	0.15	

In this table the blows per minute and the foot-pounds per blow at the various pressures are taken from curves plotted from the results of a number of tests made on machines of this type of construction.

From these results it appears that the drilling speed in this particular rock, and for this particular type of machine, depends largely upon the strength of the blow, within certain limits. The data are insufficient as yet to say more on the subject. In general this table confirms the results shown in Fig. 4 and 5.

LOSSES DUE TO DEFECTS.

The following tests show what loss may be caused in drilling speed by various defects in machines. Drill No. 516 was tested to find the effect of different conditions of feed packing leather.

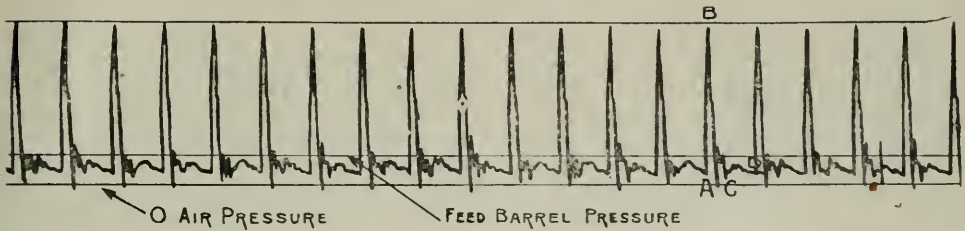


FIG. 3. No. 205. AIR PRESSURE, 100 LB. BLOWS PER MINUTE, 1234. FOOT-POUNDS PER BLOW, 50.

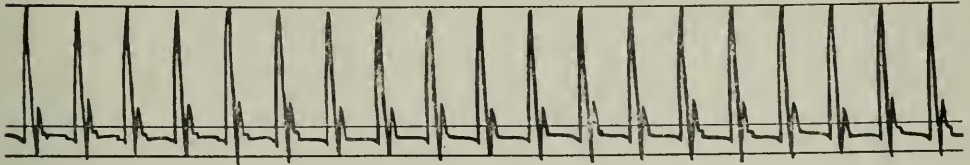


FIG. 4. No. 217. AIR PRESSURE, 96 LB. BLOWS PER MINUTE, 1260. FOOT-POUNDS PER BLOW, 40
DRILLING SPEED IN HARD ROCK, 105 FT. PER MINUTE AT 84 LB. PRESSURE.

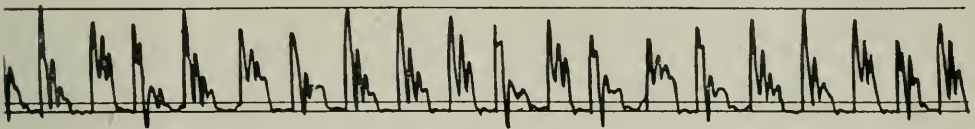


FIG. 5. No. 227. AIR PRESSURE, 84 LB. BLOWS PER MINUTE, 1272. AVERAGE FOOT-POUNDS PER BLOW, 15.
DRILLING SPEED IN HARD ROCK, 0.05 FT. PER MINUTE AT 84 LB. PRESSURE.

Packing.	Gage.	Blows per Ft.-lb. per	
		min.	blow.
New	95	1356	44
Old	95	1332	39
Damaged	95	1296	34

Drills No. 507 and No. 09152, the latter a feed-screw machine, which had been reported from underground as being in "good shape," but unable to do satisfactory work, were tested before and after equipping with new cylinders. Both these machines were reported as "doing well" when again used in the mine. It should be noted that the blows per minute vary but little.

Machine.	Cylinder.	Gage.	Blows Ft.-lb. per	
			min.	blow.
No. 507.....	old	98	1212	21
.....	new	95	1176	36
No. 09152.....	old	95	1248	16
.....	new	97	1224	36

As only one test was made to find the effect of various lubricants upon a new machine, the

following figures are interesting, but not conclusive. A worn cylinder might give less pronounced differences.

Lubricant.	Gage.	Blows per Ft.-lb. per	
		min.	blow.
Heavy	95	1116	25
Medium	95	1212	34
Light	95	1224	38

The statement is frequently made that excessive air consumption indicates that a drill is in bad condition. From a large number of tests, machines of type No. 200 and No. 500 have been found to have an average air consumption of 75 to 80 cu. ft. free air per minute at 90 lb. gage pressure. A test of a machine of this type using 90 cu. ft. of free air at the same pressure, gave 1,296 blows per minute and 43 ft.lb. per blow. From this it would seem that increased air consumption does not necessarily indicate that a machine will do poor work.

As a further example of the usefulness of the tester, this instance is cited. Four new valves were obtained from the manufacturers and were placed in machines. The tester

showed that one failed to meet the standard set. Upon investigating, a piece of steel cutting was found concealed in one of the ports. This had throttled the air sufficiently to reduce the strength of blow about 35 per cent.

Although many tests have already been made, the data are by no means complete. We believe, however, it has been shown that by means of this device it is possible to set a standard which all machines must attain before leaving the shop, thereby facilitating the problem of drill maintenance. No figure in dollars can at present be given for the saving effected; but it may be stated that complaints from the mine about the condition of machines have been materially reduced.—*Mining and Scientific Press*.

AN AUTOMOBILE COMPRESSED AIR STUNT

Electrical Record tells about a man who had a fine country place and also two automobiles which he got into the habit of employing for various incidental service. One day when the Franklin machine was running the lawn mower the Pierce was employed upon a job which was out of the usual lines.

It seems that the house, a big roomy one, is lighted from a gasoline tank located about 25 feet from the house and sunk about five feet below the surface of the lawn. The illuminating gas is obtained by forcing air into the tank from an air pump in the cellar, this air mixing in varying proportions with the gasoline vapor, and passing from the tank through the purifier to the gas jets. The proportion of air to gas vapor is regulated by cams designed for this purpose and attached to the air pump. Owing to the drawing off of the gas vapor, the 100 gallons of high grade gasoline which were put into the tank two years ago were about devolatilized, and the lights were getting dimmer every day, even with a mixture of 10 per cent. air and 90 per cent. gas vapor. Then the problem was to get the devolatilized gasoline out of the tank so it could be replaced with new and more volatile gasoline. It would have taken a day to pump it out by hand, and a plumber in that part of the country would probably charge \$25 for the job.

Three pipes lead from the gasoline tank to the ground surface immediately above it; one of them is used for filling purposes and goes into the upper part of the tank; the second goes

down to the bottom of the tank; the third contains the chain attached to the float that tells the level of the gasoline in the tank. This is what happened. The air pump on the Pierce was connected by hose and air valve to the pipe running from the ground to the top of the tank. The garden hose was connected to the car radiator, and the draw-off radiator cock opened. Empty barrels and buckets were placed close to the pipe leading from the bottom of the tank to the ground, and a short length of rubber hose was attached to this pipe. The driving gear was thrown out, the Pierce engine started, the air pump gear was thrown in, and the garden hose valve opened wide enough to give a fair flow of cold water through the radiator. The air gage showed a pressure of about 30 lb. After ten minutes of pumping, the gasoline could be seen rising in the tank, and five minutes later it gushed out of the main pipe at the rate of about three gallons a minute. The entire tank was emptied in about half an hour, the gasoline obtained being emptied into the tanks of Franklin and Pierce cars, and utilized by them, in turn, to cut the lawn and pump more gasoline out of the house lighting tank. The float valve chain in the third pipe showed when the tank was empty. The warm water from the radiator was used for washing the hands free from gasoline, rust, and dissolved rubber.

ATMOSPHERIC COOLING

The cooling power of the atmosphere depends upon other things than its temperature and the temperature of the body cooled. Thus, the wind is an important factor; as is the radiating power of the body in question. Dr. J. R. Milne, of Edinburgh, has described to the Scottish Meteorological Society an instrument for measuring the rate of cooling from a standard surface maintained at a fixed temperature of 98.4 deg. Fahr. This is "blood heat," and appears to have been chosen in order that the readings of the instrument may be a measure of analogous effects upon the human body. The device consists of a cylinder of thin copper, insulated except for its hemispherical top with plaster of paris. It is filled with paraffin oil, and the amount of electrical energy necessary to keep the oil at blood heat is continuously recorded. Hence may be deduced the loss of calories per square centimeter per second.

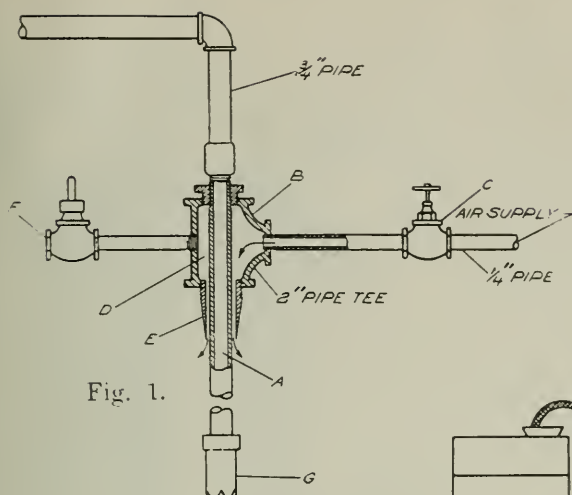


Fig. 1.

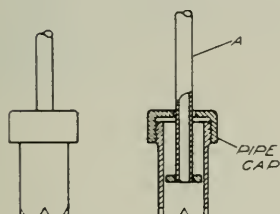


Fig. 3.

A BARREL EMPTYING DEVICE

Fig. 1, from *Practical Engineer*, is descriptive of a simply constructed device for quickly and easily removing practically the last drop of oil from a barrel by means of compressed air, and placing it in a tank located almost any place about the plant where the barrel can be rolled or where a hose will extend.

The long nipple A reaching down into the barrel is threaded back at its upper end to pass through a reducing bushing in the upper end of the 2-in. pipe tee B. This forms an air or pressure chamber D independent of the interior of the pipe A. The lower end of the pipe tee B is fitted with a taper sleeve or nipple E, which is to fit the various sized bungholes of the different barrels with which the device may be used. The air supply from valve C is through a 1/4-in. pipe, and passing out of the chamber D around the pipe A exerts its pressure over the top of the oil, forcing it up through the pipe A to the delivery end and into the storage tanks. The side opposite the air supply pipe connection is drilled and tapped

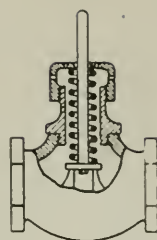


Fig. 2.

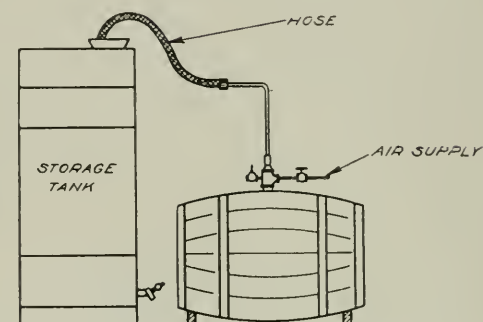


Fig. 4.

out for a 1/2-in. short nipple, to which is attached the safety valve F. The safety valve is readily made from an old 1/2-in. globe valve by removing the threads from bonnet and stem and inserting a spring of a moderate degree of resistance to hold the valve to its seat, Fig. 2.

To the lower end of the pipe A is attached the sliding sleeve G to reach to the bottom of the barrel in case its diameter should be of a size to prevent the nipple A from getting near enough to empty the entire contents. The sleeve G is also constructed of pipe fittings in the manner shown by Fig. 3.

INSTALLING COMPOUND PNEUMATIC MINE LOCOMOTIVES

The Inspiration Consolidated Copper Co. has placed an order for six compressed-air locomotives with the H. K. Porter Co. A high-pressure Ingersoll-Rand compressor has also been purchased with sufficient capacity to serve 14 of the locomotives, which is the number it is expected eventually to employ. The

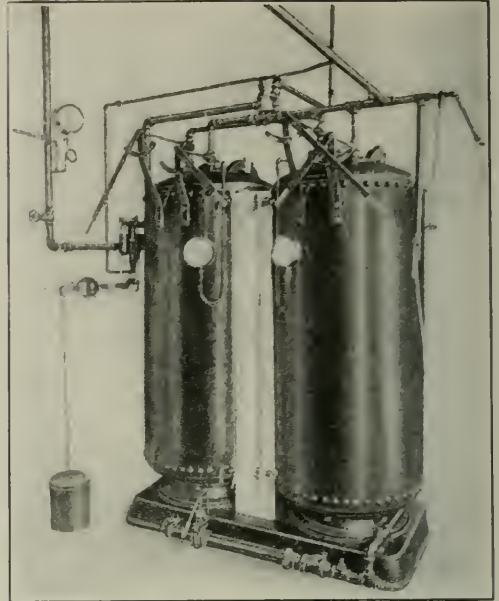
locomotives are 10-ton machines of the two-stage type. The main storage tank is charged with air at a pressure of 800 lb. from charging stations conveniently located about the mine and connected by pipe line with the compressors. The air in the pipe line is carried at 1000 lb. in order to provide a reserve supply available for charging the locomotives immediately and rapidly. It is estimated that with the design of charging station used, the locomotive will be able to come to rest, receive a charge of air, and be in motion again in 90 seconds.

The air from the engine reservoir is dropped by means of a reducing valve to 250 lb. before it enters the high-pressure cylinder. In this cylinder it expands from 250 lb. to 50 lb., and performs approximately one-half of its work. By this expansion the temperature is dropped to about 140° below that of the surrounding atmosphere, and to restore it approximately to atmospheric temperature before entering the low-pressure cylinder, it is passed through an interheater, which consists of an elongated cylinder filled with small tubes through which atmospheric air is drawn at high velocity by means of a draft induced by the low-pressure cylinder exhaust. The low-pressure cylinder has about four times the volume of the high-pressure and exhausts the air at atmospheric pressure. It is stated that numerous tests have demonstrated that this type of compressed-air locomotive under average conditions is 50% more efficient than the old-type single-expansion machine.—*Eng. and Min. Journal*.

WATER DISPLACEMENT AIR METER

The ordinary type of meter which consists of some form of motor arranged to register the volume of gas passing through it, on a dial, by means of a train of gears, was found to be unreliable for accurate work where large volumes and high pressures were used and close readings were wanted. For the purpose of accurately gaging such flow the Ingersoll-Rand Co. designed and put in use the meter shown in the accompanying illustrations.

Fig. 1 is a section through the meter. Figs. 2, 3 and 4 are diagrams of the meter, showing different arrangements of the valves. The meter consists of two tanks *A* and *B*, Fig. 1, of the same size mounted side by side on a base. The upper portions of these tanks are connected to the source of supply by the pipe



DISPLACEMENT AIR METER.

M, the opening into the tank *A* being controlled by the valve *H*, and into the tank *B* by the valve *G*. This is the inlet line. The outlet line is also connected to the top of the tanks by the pipe *N*, the opening into the tank *A* being controlled by the valve *K*, and to the tank *B* by the valve *J*.

The tanks are connected with each other at the bottom through the openings *C* and *F* by the pipe *D*. In this pipe line *D* is a valve *E* arranged to close communication between the tanks. This valve is of the quick-opening type and should be of the kind known as a gate valve, so that it will offer very little resistance to the flow when open. The tank *A* is provided with a gage glass *V* connected to the upper portion of the tank at *U*, and the lower portion at *W*. The tank *B* is provided with a similar gage-glass *S* connected with the upper portion of the tank at *R* and the lower portion at *T*. The tank *A* is provided with a pressure-gage *Q*, and tank *B* with a similar gage *P*.

The inlet line is provided with a pressure-reducing valve *L*. While this is not essential to the meter, it is a great convenience, as it prevents fluctuations in the pressure on the inlet line from affecting the reading of the meter, and, further, it allows the meter to be used on pressures lower than that of the source of supply.

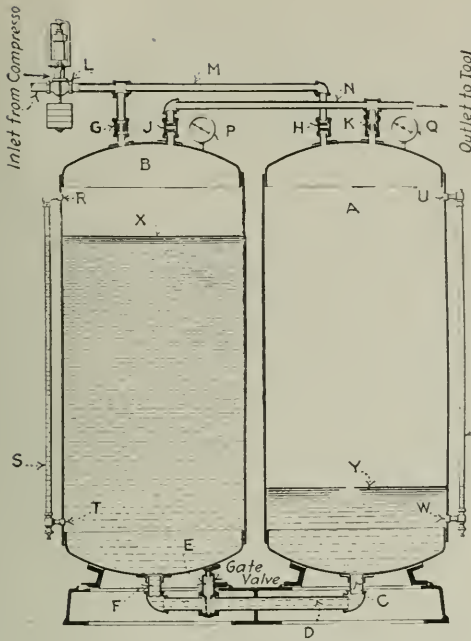


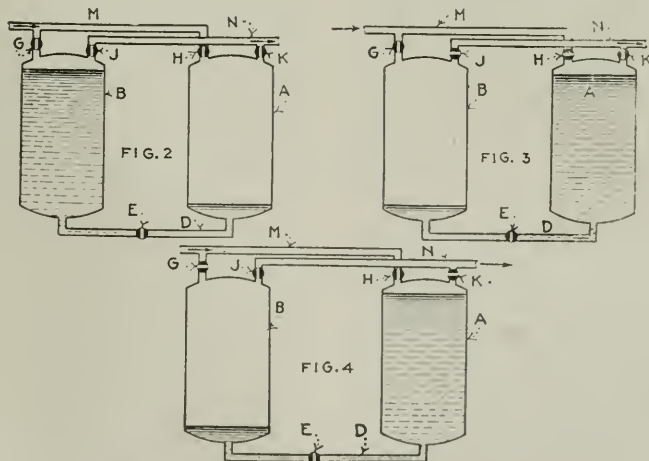
FIG. 1. SECTION OF DISPLACEMENT METER.

The reducing-valve *L* is set for the desired pressure. The machine whose capacity is to be measured is connected to the outlet line. The valves are now set as shown in Fig. 2, the top portion of each tank being open to both the inlet and the outlet line. The valve *E* in the line *D* being closed, the water is held stationary in each tank. With the valves in this posi-

tion, air from the inlet line will pass through the tanks directly to the outlet line and through the machine connected thereto. In this state the meter acts as a receiver for the storage of air and has no effect on the air passing through it.

To measure the volume of air passing through the machine, the throttle valve on the machine is first closed. As soon as the pressure in the tanks becomes equal, as indicated by the gages *P* and *Q*, the valves are changed to the position shown in Fig. 3. The tank *B* is now in communication with the inlet line but cut off from the outlet line. The tank *A* is opened to communication with the outlet line but closed to the inlet line. The level of the water in the gage-glass *S* is noted, and the valve *E* is opened. The valves are now in the position shown in Fig. 1, and the meter is ready to measure the volume of air passing through the machine.

When the throttle on the machine is opened, the air in the tank *A* passes through the outlet line to the machine. This causes a slight reduction in pressure in the tank *A*. The air in the tank *B* now causes the water to flow from the tank *B* to the tank *A* again, equalizing the pressure in both tanks, the pressure in the tank *B* being maintained by the air from the inlet line *N*. This flow of water causes a drop in the level of the water in the gage-glass *S*. At the end of the interval during which it is desired to measure the volume of air used, the valve *E* is quickly closed.



SHOWING DIFFERENT POSITIONS OF VALVES.

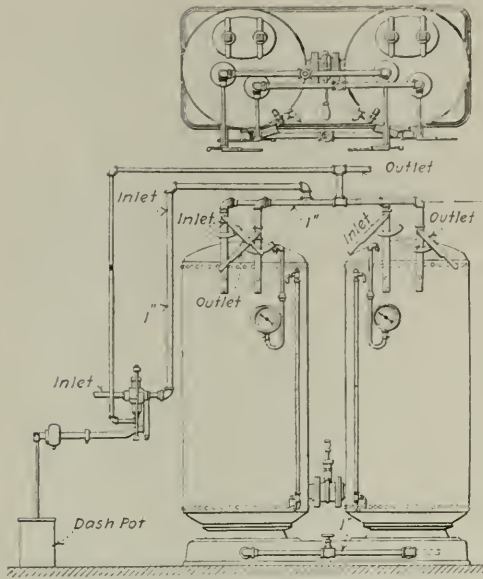


FIG. 5.

This prevents further flow of water. The drop of level in the gage-glass *S* is now measured, and from this the volume of air used is calculated, the volume of the tanks *A* and *B* having been previously determined.

When the level of the water rises to the top of the tank *A*, the valves in the inlet and outlet lines are thrown to the position shown in Fig. 4. The meter is now ready for further measurements after the pressure in the tanks has been equalized and the valve *E* opened as described. The conditions are now reversed and the water will flow from the tank *A* to the tank *B*, readings being taken on gage-glass *V*. In actual practice the valves on the meter can be manipulated with such rapidity that it is not necessary to stop the working of the machine to be tested, and any number of readings can be taken while the machine is in constant operation.

When using the meter, readings are taken by using a graduated board, which is placed behind the water-gage glasses, one graduation being used for each pressure. At the beginning of the test a rubber band is placed on each water-gage glass showing the height of the water, and at the conclusion of the test the drop may be easily measured on the graduated stick, thus giving the amount of air used.

THE NEW YORK COMPRESSED AIR WORKERS' LAW

The following is a complete copy of the law, as radically amended by the New York Legislature, governing the conditions under which labor may be employed in compressed air. It is understood that the law as it now stands has the approval both of the contractors engaged in that class of work and of the Union of Compressed Air Workers.

Section 134-a. HOURS OF LABOR—All work in the prosecution of which tunnels, caissons or other apparatus or means in which compressed air is employed or used shall be conducted subject to the following restrictions and regulations: When the air pressure in any compartment, caisson, tunnel or place in which men are employed is greater than normal and shall not exceed 21 lb. per sq. in., no employee shall be permitted to work or remain therein more than eight hours in any 24 hours and shall only be permitted to work under such air pressure provided he shall, during said period, return to the open air for an interval of at least 30 consecutive min., which interval his employer shall provide for. When the air pressure in any compartment, caisson, tunnel or place in which men are employed is greater than normal and shall equal 22 lb. and does not exceed 30 lb. per sq. in., no employee shall be permitted to work or remain therein more than 6 hours, such four hours to be divided into two periods of three hours each with an interval of at least one hour between each such period. When the air pressure in any such compartment, caisson, tunnel or place shall exceed 30 lb. and shall not equal 35 lb. per sq. in., no employees shall be permitted to work or remain therein more than four hours, such four hours to be divided into two periods of two hours each, with an interval of at least two hours between each such period. When the air pressure in any such compartment, caisson, tunnel or place shall equal 35 lb. and shall not exceed 40 lb. per sq. in., no such employee shall be permitted to work or remain therein more than three hours in any 24 hours, such three hours to be divided into periods of not more than one and one-half hours each, with an interval of at least three hours between each such period; when the air pressure in any such compartment, caisson, tunnel or place shall equal 40 lb. and shall not equal 45 lb. per sq. in., no employee shall be permitted

to work or remain therein more than two hours in any 24 hours, such two hours to be divided into periods of not more than one hour each; with an interval of at least four hours between each such period; when the air pressure in any such compartment, caisson, tunnel or place shall equal 45 lb. per sq. in. and shall not exceed 50 lb. per sq. in., no employee shall be permitted to work or remain there more than 90 min. in any 24 hours and such 90 min. to be divided into periods of 45 min. each, with an interval of not less than five hours between each such period; no employee shall be permitted to work in any compartment, caisson, tunnel or place where the pressure shall exceed 50 lb. per sq. in., except in case of emergency. No person employed in work in compressed air shall be permitted by his employer or by the person in charge of said work to pass from the place in which the work is being done to atmosphere of normal pressure, without passing through an intermediate lock or stage of decompression, which said decompression shall be, where the work is being done in tunnels, at the rate of three pounds every two minutes unless the pressure shall be over 36 lb., in which event the decompression shall be at the rate of one pound per minute; and which said decompression shall be, where the work is being done in caissons, at the following rates:

Where pressure is not over 10 lb. per sq. in. the time of decompression shall be one minute; when pressure is over 10 lb., but does not exceed 15 lb., the time of decompression shall be two minutes; when pressure is over 15 lb., but does not exceed 20 lb., the time of the decompression shall be five minutes; when pressure is over 20 lb., but does not exceed 25 lb., the time of decompression shall be 10 min.; when pressure is over 25 lb., but does not exceed 30 lb., the time of decompression shall be 12 min.; when pressure is over 30 lb., but does not exceed 36 lb., the time of decompression shall be 15 min.; when pressure is over 36 lb., but does not exceed 40 lb., the time of decompression shall be 20 min.; when pressure is over 40 lb., but does not exceed 50 lb., the time of decompression shall be 25 min.

All necessary instruments shall be attached to all caissons and air locks showing the actual air pressure to which men employed therein are subjected, and which instruments shall be

accessible to and in charge of a competent person who shall not be employed more than eight hours in any 24 hours.

Section 134-b. MEDICAL ATTENDANCE AND REGULATIONS—Any person or corporation carrying on any tunnel, caisson or other work in prosecution of which men are employed or permitted to work in compressed air, shall, while such men are so employed, also employ and keep in employment, one or more duly qualified persons to act as medical officer or officers who shall be in attendance at all necessary times while such work is in progress, and whose duty it shall be to administer and strictly enforce the following:

(a) No person shall be permitted to work in compressed air until after he shall have been examined by such medical officer and reported by such officer to the person in charge thereof as found to be qualified, physically, to engage in such work.

(b) In the event of absence from work, by an employee for 10 or more successive days for any cause, he shall not resume work until he shall have been re-examined by the medical officer and his physical condition reported, as hitherto provided, to be such as to permit him to work in compressed air.

(c) No person known to be addicted to the excessive use of intoxicants shall be permitted to work in compressed air.

(d) No person not having previously worked in compressed air shall be permitted during the first 24 hours of his employment to work for longer than one-half a day period as provided in Section 134a; and after so working shall be re-examined and not permitted to work in a place where the pressure is in excess of 15 lb. unless his physical condition be reported by the medical officer, as heretofore provided, to be such as to qualify him for such work.

(e) After a person has been employed continuously in compressed air for a period of three months he shall be re-examined by the medical officer and he shall not be allowed, permitted or compelled to work until such examination has been made and he has been reported, as heretofore provided, as physically qualified to engage in compressed-air work.

(f) The said medical officer shall at all times keep a complete and full record of examinations made by him, which record shall

contain dates on which examinations were made and a clear and full description of the person examined, his age and physical condition at the time examined, also the statement as to the time such person has been engaged in like employment.

(g) Properly heated, lighted and ventilated dressing rooms shall be provided for all employees in compressed air, which shall contain lockers and benches and shall be open and accessible to the men during the intermission between shifts. Such rooms shall be provided with baths, with hot- and cold-water service and a proper and sanitary toilet.

(h) A medical lock shall be established and maintained in connection with all work in compressed air when the maximum pressure exceeds 17 lb. as herein provided. Such lock shall be kept properly heated, lighted and ventilated and shall contain proper medical and surgical equipment. Such lock shall be in charge of a certified trained nurse selected by the medical officer, who shall be qualified to render temporary relief.

(i) Whenever in the prosecution of caisson work in which compressed air is employed, the working chamber is less than 10 ft. in length and when such caissons are at any time suspended, or hung, while work is in progress, so that the bottom of the excavation is more than nine feet below the deck of the working chamber, a shield shall be erected in the working chamber for the protection of the workmen.

(j) Whenever in the prosecution of work in which compressed air is employed, a shaft is used, all such shafts shall be provided with a safe, proper and suitable ladder for its entire length.

(k) Whenever in the prosecution of work in tunnels, caissons or other apparatus or means in which compressed air is employed or used, lights other than electric lights are used, the said lights shall at all times be guarded.

(l) All passage ways in work, wherein compressed air is employed or used, shall be kept clear and properly lighted.

The Pennsylvania System has about 2872 steel passenger cars in service, which is one-half the total number of such cars in service in the United States.

FINDING THE DEW-POINT

A simple method of determining the dew-point in ordinary atmospheric conditions is described by Heggendorff in the *Physikalische Zeitschrift* as follows: Take a cup of thin metal, say silver or copper, fill it with water and introduce the bulb of a thermometer. Then add slowly some salt, such as sal ammoniac or hyposulphite of soda, the solution of which lowers the temperature of the mixture, meanwhile stirring the liquid with the thermometer. At the precise moment when the outside of the cup begins to show moisture note the temperature registered by the thermometer, and this will be the dew-point temperature of the surrounding air. The humidity percentage at normal temperature may be ascertained from this by the aid of the proper tables.

A COMPRESSOR SUGGESTED FOR SAFETY

The oil tank steamer *Saranac*, carrying 6300 tons of oil from New York to Calcutta, when seven miles from Point de Galle, Ceylon, and three miles from shore, struck an uncharted rock three times and it was found that two of the tanks in the middle of the ship were letting in water. The water lifted the oil to the top of the tank and there it stopped, and in this condition the ship was run up to Calcutta, a distance of 1000 miles and taking five days. The vessel went into dry dock and only then the extent of the damage was discovered. Fore and aft were two huge rents in the plates, many of which had been started, and in the middle of the hull was a gash 20 ft. long and 1 in. wide, while here and there were dents big enough for a man to put his head through. The top of the tank was evidently oil tight, or air tight, and a small compressor could soon have forced in air enough above the oil to drive the water out, leaving the ship as light and as high out of the water as before the accident.

July 4 this year marked the seventy-third anniversary of the initial sailing of the *Cunard* liner *Britannic* from the Mersey for Boston, establishing the first regular steamer service between England and America. This first trip of the *Britannic* occupied fourteen days and eight hours. The record of the *Mauretania* is less than one-third of this: four days, ten hours and forty-one minutes.

COMPRESSED AIR

MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

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AN OVERSIGHT IN THE COMPRESSED AIR LAW

BY FRANK RICHARDS.

Working in compressed air is an occupation which has its dangers, and the conditions under which such work is carried on come legitimately under the cognizance of the law. The regulations prescribed in the amended law of the State of New York must have general approval, as to their intent at least.

As to the precise conditions to be insisted upon for compressed-air workers, and especially the time and pressure limits in decompression, there must always be more or less room for discussion, with differences of opinion unreconciled after all. When records and experiences are appealed to they are found to vary much in their testimony and to be more or less contradictory.

This may result perhaps from the overlooking of two important conditions having to do with the health and safety of compressed-air workers, viz., the breathable condition of the air, as determined principally by the volume furnished, and also its temperature.

It may fairly be assumed that the condition of the worker as he enters the decompression chamber must have its effect all through the decompression in determining its success and the time necessary for its safe completion. From discrepancies in the results of decompression, where the pressures and times have corresponded in the different cases, it may be a simple matter to assume that the condition of subjects in the different cases as they have entered the decompression chamber (the conditions resulting from their hours of work under pressure and according to the character of the confined atmosphere, as to oxygen content, etc.) may not have been the same. If a man has worked his stint in the compressed air with the air as pure and as rich in oxygen as possible, and also reasonably cool, he may be expected to be, all through the decompression and at the end of it, in much better condition than one who has worked almost to the verge of complete collapse in hot air which has not been constantly and copiously renewed.

There is nothing about the use of compressed air in caissons and tunnels which provides for any automatic renewal of the air, or the taking care of the condition of it in any

way. The principal function of compressed air in the caisson is to prevent the water from forcing its way in under the lower edge of it, and, providing there were no leakage, the only compressed air functionally required would be for increasing the pressure as the caisson was sunk deeper. It is evident, however, that men could not live and work in air confined like that, and it therefore must be constantly renewed. It is only necessary to force in the air in sufficient quantity; the surplus will constantly escape under the lip of the caisson, and the pressure can never be increased above that required to resist the water pressure.

If sufficient compressor capacity is provided and kept operative it is all that can be required, but as this is an expense there is always some temptation to keep the supply of newly compressed air as low as possible, with the result that it may sometimes be deficient. This should not be permitted, and it would seem to be entirely within the scope of the law, when it undertakes to secure safe and proper working conditions, to insist that sufficient air shall be supplied and that the air within the working chamber shall be in as respirable condition as circumstances will permit. This would be to the interest of the contractor, however he might regard it, since it would enable the men to work with higher efficiency.

One objection to the use of the electric light in the caisson is that it gives no intimation of the condition of the air, as would a candle, and it might be very proper to require that at least one candle should be kept always burning in the caisson, and as long as its flame glowed bright and clear the men would have no occasion to worry about the respirable condition of the air.

There is, however, the temperature of the air to be considered. In caisson work, which for each individual caisson does not usually last long, it is customary to supply the air from a single-stage compressor located nearby. The law contemplates working in compressed air up to a limit of 50 lb. gage. When air with an intake temperature of 60° F. is compressed to only 20 lb. the final temperature is above 200° F., and with the intake temperature only a little higher the delivery temperature would be above that of boiling water. Some of this heat is undoubtedly lost in trans-

mission, but the air must enter the caisson very hot, and it goes without saying that in every case an aftercooler should be required for the air, and that there should be a constant record of the temperature at which it enters the caisson, with a predetermined limit which should not be exceeded.

When compressed air is employed for the driving of subaqueous tunnels the condition of the air in the working chamber may be expected to be much better for the proper respiration of the workers than in the caisson. The air compressed is generally transmitted such a distance that the heat of compression disappears, so that little attention need be given to the working temperature, and then the air is constantly escaping, so that its renewal is a necessity for the approximate maintenance of the working pressure. At the tunnel face there is no balance of pressures as in the caisson. It must always be that in order to maintain sufficient pressure to hold back the water near the bottom of the tunnel there must be a considerable excess of pressure at the top of the tunnel and the air is bound to escape, demanding constant replacement.

When the tunnels were being driven under the East River for the Pennsylvania R. R., those who crossed the river by the 34th St. ferry had no need to be told how copious was the escape of the air, as the boiling of the water spoke for itself.

It is not difficult for us to believe that the excellent record of the East River tunnels as to caisson disease among its workers may be attributed, not only to the strict and careful decompression practice, but also to the excellent condition of the workers before submitting themselves to the decompression.

It will be noticed that the new law having to do with compressed-air practice deals almost entirely with the regulations for decompression, and this it does so thoroughly that the workers who submitted themselves to the decompression in strict accordance and in full compliance with the rules prescribed might be smothered in the chamber and taken out dead. Gradual decompression, which is the only thing insisted upon by the law, could be accomplished by merely shutting the men into the chamber under the full pressure and then slowly letting off the pressure according to schedule.

In the decompression, if nowhere else, the

men should have pure air and lots of it, the air should be at a uniform temperature and the temperature should be that determined to be most suitable. Both these conditions are more or less imperative and are not difficult, although costing something, to provide, but the law says nothing about them.—*Engineering News*.

AIR CONDITIONING FOR TEXTILE MILLS

BY FREDERICK W. PARKS.

Artificial humidification is no longer a theory. For years it was on trial, as it were, in textile manufacturing, but rapid progress has been made in the last few years. Knowledge of the subject is becoming general, the needs for textile working conditions are better understood, and the practice is becoming more standardized. Humidifiers are no longer considered a luxury and their adoption a whim, and few mills are now built without at least considering the need of humidifiers. Few cotton mills, indeed, are now built without installing humidifiers at the start.

There are so many types of apparatus on the market that the engineer or mill owner should have no trouble in selecting the one best suited to the needs of the case. Some are designed especially for new mills, others for either old or new plants, some for small isolated units, and so on. Like the Kentuckian's whiskey, all are good, but some are better than others.

A circular letter upon this topic was written to textile plants throughout the country, and 81 mills replied. As evidence of the value of humidification, an analysis of reports from these mills is highly interesting. The points on which these mills reported were as follows: The influence of humidifiers on production, floor sweeps, invisible waste, second quality goods, static electricity, broken ends in spinning, loom shut down, strength of product, mill temperature, health of operatives and estimated return on investment.

It is an interesting fact that not one unfavorable reply or discordant vote of any sort was received. Many would not report at all on some points for lack of data, as for instance a new mill which had never been without humidifiers.

The experience of one mill (a Northern cotton yarn mill about three years ago and humidified when built) is interesting enough to

quote here: "Our invisible waste for 1911 was 1.4%, which is very low. Our production was 93%. Our regain from cotton to yarn averaged 6% on 2,000,000 pounds of cotton per year. Our humidifier cost \$10,000."

These reports were not obtained for the purpose of exploiting any particular make of humidifier, for these 81 mills had 11 different types in use. Among these 57 mills were silk, rami, worsted and cotton mills, although cotton mills predominated. In number they were equally divided between the North and South, so the reports may be considered as fairly representative of the textile industry.

So far, I have been giving you the evidence to prove the need of humidifiers. In building a new mill, admitting humidification to be necessary, the next step is the selection of the proper type of apparatus. Some sort of system can be purchased at almost any price you wish to pay. There is one point, however, that is interesting enough to bring out right here. Be sure to purchase capacity enough. Higher humidities are being demanded right along. The man that asked for 65% in cotton weaving five years ago is now demanding 75% and wishing he could get 80%.

Theoretically, and I emphasize that word theoretically, humidification is only one of three treatments that the mill air needs. The other two treatments are ventilating and heating, and these three functions combined may properly be called conditioning.

There is no close relationship between these three variables, for each must be capable of adjustment or operation at any load at times entirely independently of the other two, or in any possible combination with the other two.

Take, for instance, a zero morning in winter. We may run our heating system at peak from midnight till starting time. At five o'clock, the metal being then warm and there being no danger of precipitation and rusting, we may start our humidifiers so as to have a proper amount of humidity when the power starts. With the starting of the power and the coming to work of the employees we start our ventilation at peak and maintain it so all day. This air change may call for more humidity. By eight o'clock the heat of the machinery and the improved circulation of air due to revolving shafting and belting have increased the temperature so that we shut off part of the heat. By nine o'clock we may shut

off more heat if the sun is bright and there is no wind, yet our humidifiers and ventilation may not have been disturbed.

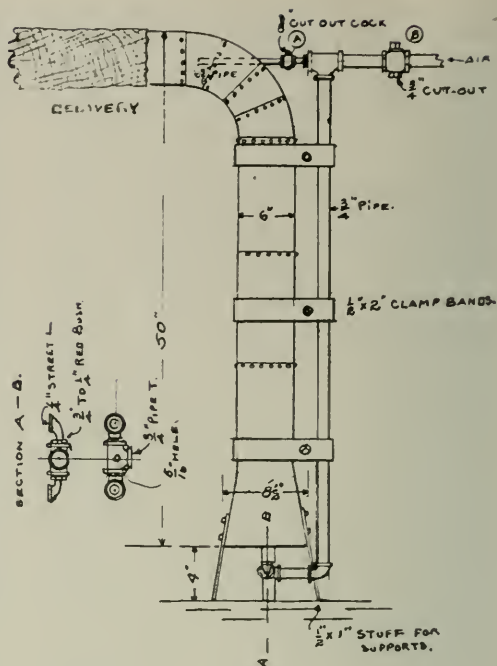
In this condition we may run until noon, when we shut off our ventilation during the noon hour because the occupants have left. We may or may not shut off our humidifiers, depending on atmospheric conditions. At sunset more heat is needed, but the demand is not as great as in the early morning because we have a mill full of warm machinery. At closing time we stop the ventilation, humidity, and heat, and repeat the process the following day. Take any working day in the year and it will call for a similar variation of these three widely varying functions.

A textile mill is not a physical laboratory, and cannot be made one. The average mill is intent on manufacturing, and cannot be expected to care for complicated delicate apparatus not a part of a manufacturing process. Our heating, humidifying and ventilating, therefore, must be as simple and as near fool proof as possible.

COMPRESSED AIR FOR TRANSFERRING GRAIN

When grain is being transported in bulk by railroad it often happens that a car containing it is disabled by accident or otherwise so that it becomes necessary to transfer the grain, and the sketch here reproduced from *Railway and Locomotive Engineering* shows an arrangement which has been employed for the purpose, using compressed air as the active agent.

The body of the apparatus as shown is a 6 in. pipe of 1-16 in. sheet iron supported by three legs, more or less, the size and number of which can be varied to suit different conditions. The pipe is enlarged at its lower end and the legs support it about 4 in. from the car floor. The compressed air pipe running down outside extends in under with a horizontal tee located at the center of the pipe, and at each end of the tee is a "street" L looking upward. As the loose grain occupies all the space at the bottom of the pipe, when the air is turned on by valve B in the air supply at the top, the blasts from the elbows send the grain up the pipe, and then valve A supplies additional air to the horizontal pipe which sends the flow along to be delivered into another car or elsewhere.



The time for emptying a car of course depends on the nature of the grain, but the dimensions indicated in the sketch were found to be well adapted for all light grains. Supplied with an unbroken flow of air at 90 to 100 lb. the device will do as much work as five or six men.

PRINCIPLES AND ADVANTAGES OF MECHANICAL REFRIGERATION

There are some lines of business in which it is evident that the installation of a refrigerating plant will give better results, as, for instance, installations requiring the refrigeration of showcases and windows, those requiring the maintenance of very low temperatures, and those in which different degrees of temperature are required for different classes of service.

Some of the advantages of mechanical refrigeration are as follows:

- (1) Lower temperatures obtained with refrigerating machines than with ice.
- (2) Absence of the dirt and muss often accompanying the use of ice.
- (3) No accumulation of slime in the refrigerator.
- (4) Refrigerators cooled mechanically are

dryer than ice-cooled boxes because the moisture in the air deposits on the cooling pipes and is frozen.

(5) Any desired temperature can be obtained and maintained.

(6) Show-windows and show cases refrigerated mechanically at any desired temperature, thus permitting an attractive display of perishable goods.

In general it may be said that almost all methods of obtaining refrigeration are based upon the fact that when a liquid evaporates or turns from a liquid into a gas or vapor, it absorbs heat from its surroundings. There are a number of liquids which are easily made to evaporate and produce this cooling effect, and but for their cost, refrigeration could be very simply produced by supplying a steady stream of the liquid and allowing the vapor or gas evaporated to escape into the atmosphere. A refrigerating machine is practically an apparatus for saving this gas which has evaporated, and returning it to its liquid form to be used over again.

In this process of recovery and condensation the gas gives out the heat which it has previously absorbed in evaporating. This heat is carried away by flowing water which absorbs it. The operation of a refrigerating machine thus causes a continuous cycle of evaporation, recovery and condensation. There are two general systems in use for producing refrigerating effects, the compression and the absorption.

In the compression system the recovery of the gas is effected by drawing it away from the point where it has been evaporated and pumping it under increased pressure into a chamber where it gives out its heat to the water-cooled walls of the chamber and returns to the liquid state ready to be used over again. A number of liquids have been used in compression refrigerating machines, those common being ammonia, carbon dioxide and sulphur dioxide.

In the absorption system ammonia is generally used and the recovery of the gas is effected by bringing it in contact with water with which it unites chemically. The solution thus formed is pumped into another chamber where the ammonia gas is driven off again by heating the mixture, and is then condensed under high pressure.

In the absorption system the liquid ammonia

as it is released by the expansion valve passes into the low-pressure portion of the apparatus, the expansion piping, which is located at the point where the cooling is to be done. While expanding, the ammonia absorbs heat as it passes, and is carried to the absorber. This is a vessel of cold water. The strong affinity of ammonia gas for water causes a ready combination, and a constant sucking is produced tending to reduce the pressure in this section of the apparatus, thus permitting the expansion of the ammonia gas.

After being absorbed, the weak ammonia is pumped into another compartment called the generator, where the ammonia gas is driven out of the water by heat. The hot ammonia gas is then passed through a condenser to be liquefied. The condenser is a series of pipes arranged in vertical rows and cooled by flowing cold water. The liquefied ammonia is collected in the ammonia receiver to be again used through the same cycle of operation. The hot liquor (water) from which the ammonia has been boiled is pumped out, cooled and again used in the absorber.

AIR HAMMER DRILLS

In a recent comprehensive article in *Mining and Engineering World* entitled Recent Advances in Butte Mining Practice, by Claude T. Rice, the following occurs:

I mention air-hammer drills. In 1907 I doubt if there was a single drill of that type in use in the district except for plugging in the shafts. Now they are used in all the mines for stoping and raising, and in some of the mines there is not a pound of stope ore that is not broken with holes put in by air-hammer drills. Quite recently there has been considerable experimenting with the Ingersoll-Rand Jack-hamer type of hand drill, which seems to have met with such great success in drilling the foot-wall ore in the amygdaloid mines of the copper country. Also at Butte several of the mine foremen are looking favorably on them, especially for drifting.

A railroad cut through coal on the new construction work of the Louisville & Nashville R. R. in the northern part of Alabama has been converted into a profitable mine by the contractor, who is selling the coal to his neighbor contractors.

(Continued from Page 6986.)

pleted to the floor above in the process of construction, with the added advantage that the planks are delivered at the exact point where they are needed. Pneumatic hoists are even more convenient for many hoisting operations.

In the modern weave room, the looms are driven from underneath, through the floor. This calls for a large number of belt holes, all of which are roughed out with augers. For this, a pneumatic boring tool may be mounted on ways hinged to a flat base. The hinge is adjusted and set at the desired angle. By standing on the base, the auger may be fed and withdrawn very conveniently. With the pneumatic tool, and two men, three times as many belt-holes are roughed out as by the old hand method.

Maple logs are often used for squeeze rolls in bleacheries and dye houses. Holes must be bored through them for the shafts. Mr. Thompson, referred to above as a pioneer in the use of compressed air in cotton making, described a satisfactory method of applying a pneumatic tool for boring these holes. He says "for this purpose the auger shaft is back-gearred to a powerful pneumatic driller, both being attached to a special carriage on an old lathe bed. The log is carried on horses at the end of the bed, and the auger fed through by hand. To drive a four-inch "pod auger" through a 10-foot log used to be a day's task for two men, the heart-breaking part of the task being due to the necessity for the frequent pulling out of the auger to clear the hole of chips. With the modern apparatus four 10-foot logs are easily bored by one man, who requires no help except in the handling of the logs themselves to and from the machine."

MISCELLANEOUS USES OF COMPRESSED AIR.

There are doubtless many other applications of compressed air in cotton mills, which the writer has not encountered, and the possibilities of the further application of pneumatic power to cotton manufacturing processes are many. The application of compressed air in the making of velour hats, to raise the nap on the hat, was recently brought to our attention. It is probable that compressed air could be similarly applied with

profit in making certain kinds of cotton goods having a nappy surface.

One cotton works which the writer visited used air pressure in a novel manner. Compressed air was piped to a tank to keep water under pressure for the operation of a heavy hydraulic freight elevator.

Several mills use air to blow the dirt and soot from the tubes of fire-tube boilers and they find that it is decidedly more satisfactory than steam for the same purpose. Boiler scale removing machines are also frequently operated by compressed air.

White walls contribute to the comfort and happiness of the operatives as well as cutting down the bills for artificial illumination. Paint or whitewash spraying machines, operating with compressed air are very efficient and convenient for this purpose, especially where they can be connected to the compressed air line, running through the mill.

Hundreds of mills are using compressed air for various purposes and we trust that this article, incomplete as it is, may be of some assistance to them and to those contemplating the use of compressed air.

NOTES

A model illustrating a new system of storing petrol (gasolene) in bulk is shown by the Hydraulic Petrol Storage Company, 11 Bothwell Street, Glasgow. The novelty of the system consists in the fact that the storage tank is always full of liquid, and that no air is admitted at any time. The liquid in the tank may be all petrol, or petrol and water, or all water. The water and petrol do not mix, and owing to the difference in their specific gravities the petrol always floats on the surface of the water. By simple, ingenious mechanism water is pumped into the tank to force out the petrol.

It is estimated that the daily production of oxygen in the United States is approximately 600,000 cu. ft. Of this quantity approximately one-half is supplied by 12 central stations situated in different parts of the country while the other half is produced by plants in individual works.

Plants require air in contact with their roots. If the soil water rises above 60 per cent of the saturation, the air is so reduced

that root development is seriously retarded. A large root system enables the crop to vigorously gather the plant food materials. Reduce root growth by having too much water in the soil and the crop is reduced accordingly, because it only has small feeding area.

A new building material, known as Tekton, which is being introduced by Ollendorff & Clarkson, Ltd., Glasgow, is stated by the London Times to be of the nature of artificial wood and to possess the strength and durability of concrete. The ingredients are magnesite, granulated slag, chloride of magnesium, and "wood flour," and its principal properties are that it is porous, has a low heat conductivity, and is sound-proof, fire resisting, odorless, and not liable to develop dry rot.

In order to facilitate the driving of the 22x30 ft. double-track Canadian-Pacific Railway tunnel of 5 miles long, through the Selkirks, Foley, Welch & Stewart, the contractors, have decided to adopt a new method, according to the *Canadian Engineer*. This method consists of first boring a parallel tunnel 7 by 8 ft., for virtually the same length. From this tunnel cross-cuts will be made at short intervals to the site of the proposed large tunnel. This will enable gangs of men and machine drills to attack the work simultaneously at scores of points. Incidentally, the "pioneer" tunnel, as it is called, will also provide ventilation, and will, for a considerable time, provide an exit in removing the rock material.

Joseph Mango, of St. Clair, was overcome with gas at Wadesville colliery, Aug. 27, and had been given up as dead, but members of the first-aid corps, after working for an hour, revived him. Mango was removed to his home very ill, but he will recover. Although his body was cold and stiff, and his pulse had apparently ceased, the rescuers, George Phulright, Joseph Cook and William Webb, wrapped him in a blanket and forced oxygen into his lungs with a pulmotor.

In population Pittsburgh ranks fifth among the cities of the United States, having as "Greater Pittsburgh" only about one-sixth that of Greater New York, but in the consumption of coal alone Pittsburgh nearly equals that of the largest city in the country. It is estimated

(no accurate data being available) that Greater New York consumes between 18,000,000 and 20,000,000 short tons of coal annually. The Pittsburgh district in 1912, according to Edward W. Parker, of the U. S. Geological Survey, consumed 17,721,783 tons of coal and about 5,000,000 tons of coke, or a total of about 22,700,000 short tons, over 10 per cent. more than all the boroughs of Greater New York. Pittsburgh also consumes millions of cubic feet of natural gas.

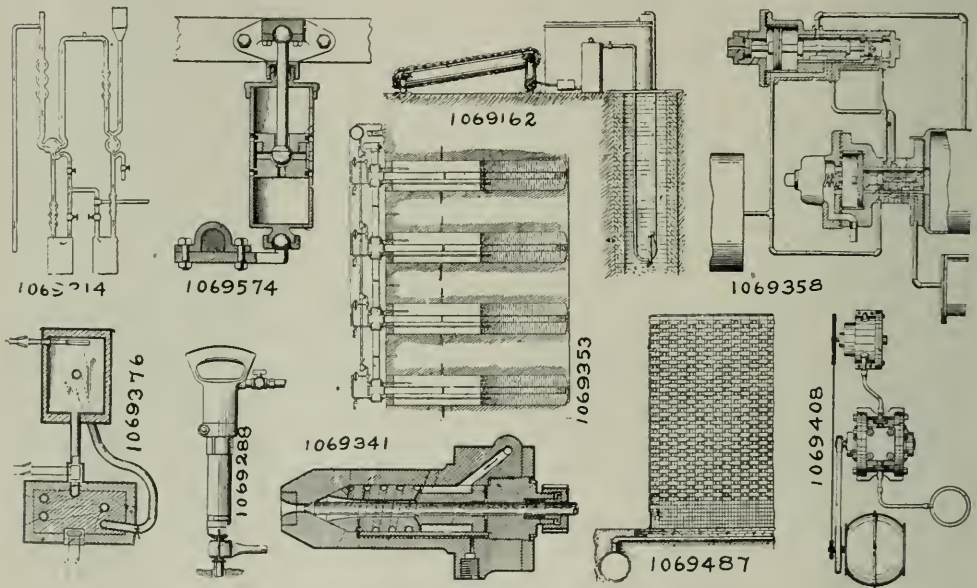
The vacuum-cleaner principle is having new applications every day; but one of the strangest is for the unloading of coal cars. It is stated that a big Austrian power plant is being equipped to handle all its coal by vacuum pipes. Coal that is graded according to Austrian standards as dust coal and nut coal is delivered in carload lots to the plant, and a great pipe is dropped into the car. The coal is sucked up through this pipe and carried to the storage bin.

There are 1,100,000 automobiles in America, or one for every two miles of country road. If all the steam locomotives (passenger and freight) were placed at equal intervals in the railway lines there would be one locomotive for every fourth mile. There are about as many passenger cars as there are locomotives, and 20 times as many freight cars as passenger cars; but all the freight cars, passenger cars and locomotives combined total only twice the present number of automobiles, and probably did not cost more than as much as all the automobiles.

A sudden and fierce fire, causing the loss of three lives, broke out in the building at the head of shaft No. 9 of the Catskill Aqueduct work in Manhattan, with 62 men working in the tunnel 450 feet below. The fire stopped the ventilating motor which supplied fresh air and the men were held in the dark, airless depths for five hours. Fire Chief Kenlon, in one of the most dangerous and spectacular rescues in the history of the department, led the firemen down long ladders while burning debris rained down about them. The perilous descent took 40 minutes and the men were found huddled back 1000 feet from the shaft and only able to stand the bad air for a little while longer.

A process whereby steel is hardened by means of compressed air is now in use by a German firm in cases where only certain parts of the metal require hardening. The customary methods of hardening by chilling the steel in water, oil, or special baths is not satisfactory in such cases, owing to the tension created between the hardened and unhardened portions of the treated metal. In the new procedure the compressed air is sprayed over the metal through specially designed nozzles, by means of which, by varying the number and spacing of the openings, the degree of hardening may be accurately graded.

Recent experiments have shown that the ordinary internal combustion motor as it stands to-day will consume alcohol slightly modified by other home-produced liquids with a very small loss in power as compared with gasoline, the loss being so small that there is practically no doubt that, if the compression were increased, it would be negligible if not entirely abolished. The common idea that a very special engine and a still more special carburetter are indispensable for using alcohol is not in accordance with facts. Alcohol with quite a small portion of benzene has proved to be a very satisfactory fuel.



PNEUMATIC PATENTS AUGUST 5.

LATEST U. S. PATENTS

¹ Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

AUGUST 5.

- 1,069,162. CATTLE-PUMP. OTIS R. NICKERSON, Drexel, Mo.
 1,069,214. SEPARATOR. JOHN N. WINGETT, Denver, Colo.
 1,069,238. FLUID-FEEDING ATTACHMENT FOR HOLLOW DRILL-STEELS. WILLIAM PRELLWITZ, Easton, Pa.
 1,069,289. FLUID - PRESSURE - OPERATED TOOL. WILLIAM PRELLWITZ, Easton, Pa.
 1,069,341. PULVERIZER FOR OIL-ENGINES. HERMANN LEMP, Erie, Pa.
 1,069,353. APPARATUS FOR PUMPING. SILAS W. TITUS, New York, N. Y.

1. The combination with a subterranean source of liquid supply and a sealed well extending into the same, of a suction pipe extending

into said well, means for maintaining air under sufficient pressure within said well to raise the liquid level to a predetermined height within said suction pipe, an air relief pipe extending into said well and into the liquid therein to a given point below the level of said liquid, and means for controlling the discharge of excess air pressure when the liquid within said well falls therein and unseals the end of said air relief pipe, substantially as specified.

1,069,358. FLUID-PRESSURE BRAKE. WALTER V. TURNER, Edgewood, Pa.

1,069,376. COOKING APPARATUS. GEORGE GILBERT BELL, Kensington, London, England.

1. The combination of an oven, an air heater for supplying heated air thereto provided with a heat storage mass having a passageway for the air therethrough deflected at numerous places, whereby the air will be retarded in its passage through the air heater and will be brought frequently into contact with the heated surfaces of the heat storage mass.

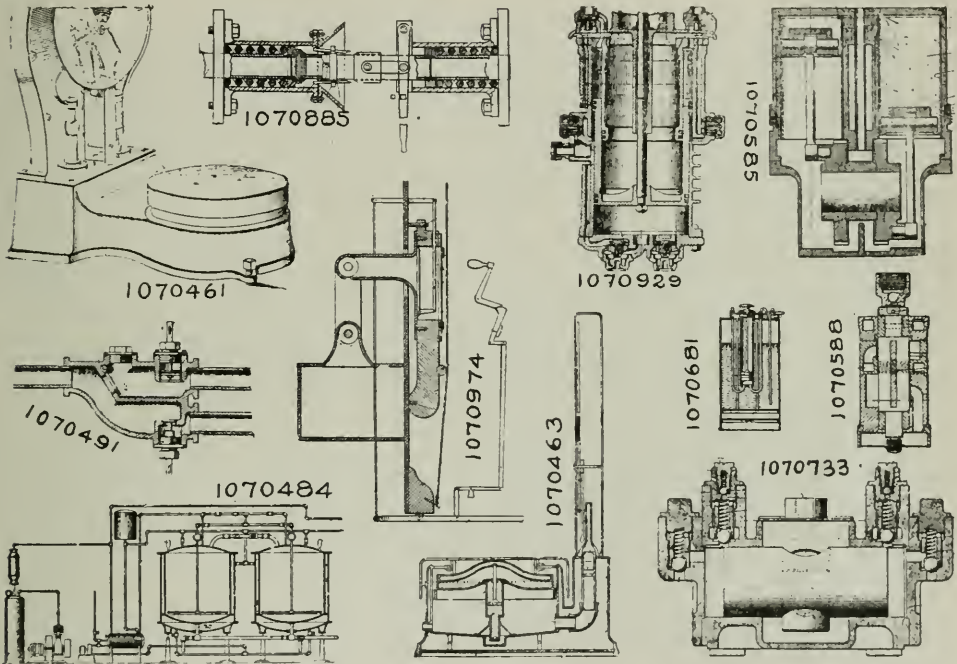
1,069,408. METHOD AND APPARATUS FOR PRODUCING HIGH VACUUMS. WOLFGANG GAEDE, Freiburg, Breisgau, Germany.

- 1,069,487. BRICK-KILN. JAMES R. SMITH, Mechanicsville, N. Y.
 1,069,510. VACUUM-PUMP. JOSEPH ZEITLIN, South Kensington, London, England.
 1,069,574. PNEUMATIC SHOCK-ABSORBER. LOUIS S. PACE and JOSEPH F. OSBORNE, Iron-aton, Ala.

AUGUST 12.

- 1,070,134-5. MILKING-MACHINE. JOHN L. HULBERT, Poughkeepsie, N. Y.
 1. In a milking machine, in combination, a teat cup, a passage for the milk constantly under and in communication with a source of suction, said passage leading from the milk discharge portion of the teat, means to intermittently compress the teat, and means to intermittently admit pressure fluid into said milk passage, between the teat discharge and the source of suction, alternately with the compression of the teat.

- 1,070,585. AIR-PUMP. CHARLES P. CLARKE, Boston, Mass.
 1,070,588. ROTARY FLUID-PRESSURE MOTOR. PHILIP J. DARLINGTON, Plainville, Conn.
 1,070,681. APPLIANCE FOR CHARGING DISINFECTING APPARATUS. JULIAN G. GOODHUE, Chicago, Ill.
 1,070,733. AIR-COMPRESSOR. WILLIAM REAVELL, Ipswich, England.
 1,070,740. APPARATUS FOR THE PNEUMATIC CONTROL OF MILKING-PULSATORS. THOMAS THOMASSEN SABROE, Copenhagen, Denmark.
 1,070,885. 'AIR-BRAKE-TUBE CONNECTION. PASQUALE GENTILE, Niles, and ANGELO DEL GIUDICE, Youngstown, Ohio.
 1,070,962. AIR-HOSE COUPLING FOR RAILWAY CARS. FRANK H. LONG, Winnemucca, Nev.
 1,070,929. AIR-COMPRESSOR. LOUIS G. STONE, London, England.



PNEUMATIC PATENTS AUGUST 19.

AUGUST 19.

- 1,070,460-1. PNEUMATIC SCALE. STEPHEN E. HARBAC, Fort Smith, Ark.
 1,070,484. PASTEURIZER. GEORGE M. KENDALL, New York, N. Y.
 1. In a pasteurizing apparatus, the combination with a liquid container having a jacket adapted to receive a temperature controlling medium, a source of such medium and connections between the latter and the jacket, of a pneumatic agitator within the container adapted to discharge streams of air through the liquid contents adjacent to the jacketed walls, a source of compressed air supply, connections between the latter and the agitator, and means for subjecting the air to the same temperature controlling medium that is introduced into the jacket prior to its arrival at the agitator.
 1,070,491. SYSTEM FOR STORING FLUIDS UNDER PRESSURE. WILLIAM B. LAKEY and GRAY STAUNTON, Muskegon, Mich.

- 1,070,974. COMBINED WIND AND STRINGED INSTRUMENT. MAX H. MATTES, New York, N. Y.

1. In a combined wind and stringed instrument, the combination of a string, means to cause the string to vibrate to produce a tone, pneumatically operated mechanism acting upon said string to modify its vibration and its tone, said mechanism including an air chest, a member comprising a reed cell, a reed connected to said member and located in close spaced engageable relation to the string, a tubular connection between the air chest and the reed cell, and means to control the passage of air through the reed cell, means to adjust said reed cell member toward or from the string so as to vary the effect of the reed upon the string, the air-chest remaining in fixed position, and means to simultaneously cause the operation of the string vibrating means and the means to control the passage of air through the reed cell.

AUGUST 26.

1,071,020. COMPRESSING AND LIQUID-EXTRACTING MACHINE. ELLIS BARTHOLOMEW, Toledo, Ohio.

1,071,059. GAS-ENGINE STARTER. STEPHEN S. KRAYEY, St. Louis, Mo.

4. In a device of the character described, a number of radial chambers arranged to receive air under pressure, and a number of radial containers arranged adjacent to said chambers said chambers being arranged to receive a supply of liquid, air inlet passages to said air chambers, passages between each air chamber and a liquid container gas outlet passages from said liquid containers, liquid inlet and outlet passages from said liquid containers, and a valve operable to control said passages, substantially as specified.

1,071,164. APPARATUS FOR THE MANUFACTURE OF BREAD. GEORGE LUNT, Formby, England.

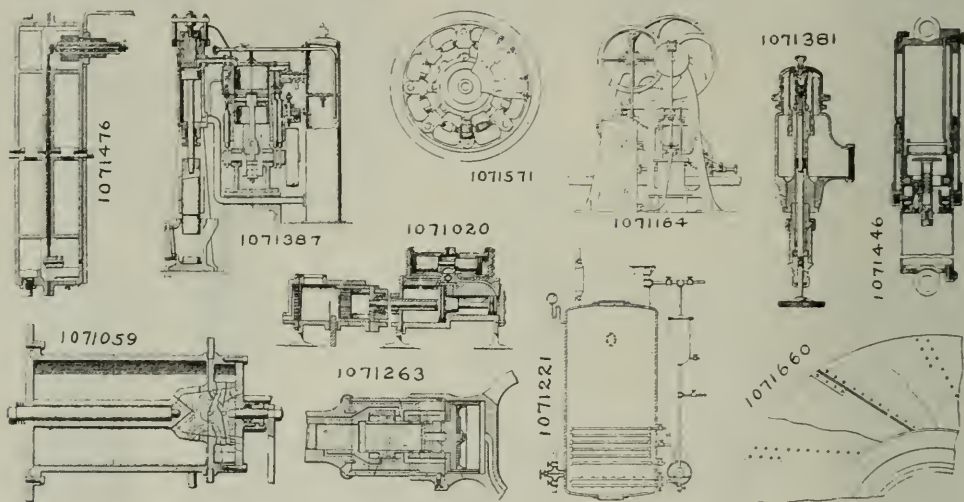
2. An improved apparatus for the treatment of dough comprising in combination an elastic

1,071,387. PERCUSSIVE APPARATUS. HANS CHARLES BEHR, Johannesburg, Transvaal.

1. In a percussive apparatus, the process of delivering an uncushioned blow, which consists in supplying on one side of a piston having an accelerated velocity a fluid pressure which does not substantially increase during the percussive stroke; supplying a varying second fluid pressure, adapted to fall to a predetermined point, on the other side of said piston; partially preventing said second pressure from varying while being supplied to said piston; and supplying additional fluid from an external source directly on said other side of said piston to prevent the said varying pressure from falling below said point, substantially as described.

1,071,446. FLUID-PRESSURE DEVICE. RICHARD LIEBAT, Watervliet, N. Y.

1. A cushion device, comprising relatively movable members forming a closed chamber, in combination with an internal compression pump having a compression chamber carried by one of said movable members, and a piston having its strokes coincident with the extension movements of said relatively movable members.



PNEUMATIC PATENTS AUGUST 26.

fluid pump, reciprocating elastic fluid supply means, elastic fluid supply controlling means, an element operating said elastic fluid supply controlling means and a traveling dough support, as set forth.

1,071,199. MINERAL - PROSPECTING APPARATUS. BENJAMIN ANDREWS, Houston, Tex.

1. In an apparatus of the kind described, the combination with a bit, of a double drill stem connected therewith formed of two concentric pipes, and means for forcing air down through the outer and into the inner pipe, the inner pipe having its open lower end disposed to receive the material removed by the bit, substantially as described.

1,071,221. APPARATUS FOR TREATING OILS WITH GASES. CARLETON ELLIS, Montclair, N. J.

1,071,263. PNEUMATIC HAMMER. GEORGE L. ROBERTSON, Philadelphia, Pa.

1,071,381. LIQUID-FUEL BURNER. ALFRED R. ANTHONY, Montrose, Pa.

1,071,446. OZONIZER. EDWARD CHARLES SPURGE, Niagara Falls, N. Y.; Louise T. Spurge, George Emerson Cox, and George Slate, Jr., administrators of said Edward Charles Spurge, deceased.

1,071,571. PNEUMATIC WHEEL FOR VEHICLES. THOMAS PENDELL, Poughkeepsie, N. Y.

1,071,632. PROCESS OF TREATING MELTED METALS, ALLOYS, AND STEELS. LOUIS MARIE VICTOR HIPPOLYTE BARADUC-MULLER, Paris, France.

1. A process of removing gases from molten steel and the like, within a vacuum chamber, comprising evacuating the air and gases from said chamber, and subjecting the air and gases evacuated from said chamber to a rapid refrigeration to a degree below 0 degree C. before reaching the evacuating apparatuses, whereby the volume and temperature of the air and gases coming from the vacuum chamber are greatly reduced and a high vacuum produced in the vacuum chamber.

1,071,660. BLADING CONSTRUCTION FOR TURBO-COMPRESSOR IMPELLERS. OTTO BANNER, Easton, Pa.

COMPRESSED AIR

MAGAZINE

EVERYTHING PNEUMATIC.

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EAST RIVER WATER TUNNEL—FULL HEADING NEAR MEETING.

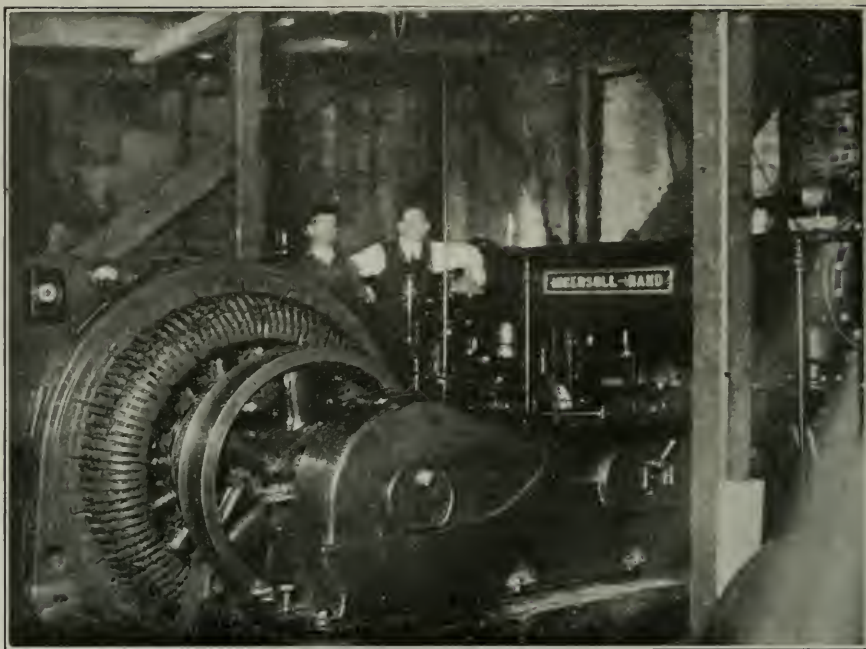
“HOLING THROUGH” THE EAST RIVER WATER TUNNEL

BY S. W. SYMONS.

Though the “holing through” of the water tube, joining the Boroughs of Manhattan and Brooklyn beneath the East River, was unaccompanied by the demonstration which marked the “holing through” of the Hudson Tunnel at Storm King, it nevertheless marks an event of great importance in this vast water supply system, and means that the completion of the

most difficult part of the city tunnel system is in sight.

The tunnel joins shaft 21 at the foot of Clinton St., Manhattan, with shaft 22 at Sands and Bridge Sts., Brooklyn. The headings met on Sept. 27th, about 700 feet below the river level, the alignment met within 0.17 ft. and the stationing within 0.03 feet. The only officials present were the Department Engineer, Walter E. Spear, and the Division Engineer, Lazarus White, who is supervisor for this part of the work. Of the 17½ miles of city tunnel there



EAST RIVER WATER TUNNEL—ELECTRIC-DRIVEN COMPRESSORS.

now remains little more than half a mile to be excavated, and New Yorkers can look forward to seeing the whole project completed well within schedule time, the latter part of 1915.

The East River Tunnel is part of contract No. 67 handled by Holbrook, Cabot & Rollins, which begins at shaft 19 and extends to shafts 23 and 24, the two terminal shafts of the city aqueduct. This contract is distinguished from the other city tunnel work in that air pressure was required to reach rock at all the shafts, the depth of rock below ground-water varying from 36 to over 100 feet. Another feature was the step shafts at either end of the contract, which eliminated inclines. The heading north of shaft 19 and south of shaft 22 being from the upper level, and those south of shaft 19 and north of shaft 22 from the lower level, the completed tunnel is designed to drain to shaft 21, which is the deepest shaft in the whole system with the exception of those at the Storm King siphon, and besides being used as a drainage shaft, will contain a 4 ft. riser for connecting to a service pipe.

In the prosecution of the work here a good average speed has been kept up from the start,

and work is progressing well within contract time.

Advantage was taken of the low cost of current offered by the Electric Companies by installing direct connected electric driven air compressors. These are of the Ingersoll-Rand PE-2 compound type equipped with intercooler and moisture trap.

At shafts 19-20-21 and 22 two machines were installed, one of 790 and one of 1108 cu. ft. capacity, making it possible to economize by running the smaller machine only when but one heading was being driven. At shafts 23 and 24, where there is only one heading, a single compressor of 790 ft. capacity was installed.

Shaft sinking after bed rock was reached, was started with drills of the Butterfly self-rotating type; at shafts 19 and 20 these drills completed the work successfully. At the other shafts Sergeant "F-94" and "E-44" drills were substituted. Shaft No. 21 was particularly difficult, due to its being a combination drainage and riser shaft and therefore irregular in section, comprising a large circle with a smaller one close by to accommodate the riser.



EAST RIVER WATER TUNNEL--TYPICAL SET-UP OF DRILLS.

The larger shaft was sunk in advance, using piston drills, the smaller shaft or riser was drilled with the rotating "Japs," and shot into the larger shaft.

Tunneling was carried on with the usual heading-and-bench method, the finished diameter ranging from 14 feet at shaft 19 to 11 feet at the terminal shafts. Progress was from 6 to 7 feet per shift; three shifts a day; drills used were mostly Sergeant "F-94" and "E-44."

Towards the latter part of the work at shaft 21 a new style of drill bit was tried out with some success. This bit was formed on round steel and was shaped like the letter "H" with the two upright bars curved to the shape of the hole and the cross-bar raised in the center so as to pulverize the cuttings. It was found that the holes were kept a great deal more accurate and that as much work could be done on 65 lb. air pressure as on 100 lb. with the old style bit, thus realizing a large saving in drill repairs and a slight saving in power cost. This experience shows that it is advantageous to investigate

different styles of bits for different rock formations.

Mucking starts generally about one hour after shooting, and continues for about 8 hours; General Electric storage battery motors are used, hauling three-car trains. At shaft 23 much water-bearing rock was struck, but was successfully handled by two electric driven pumps.

For trimming on this contract, several Ingersoll-Rand Jackhammer rotating drills are to be used. These are remarkably light machines with high drilling capacity. Concreting on this section will be carried on in much the same manner as on the balance of the rock tunnel.

Beyond the terminal shafts pipe conduits are being laid, to connect the Boroughs of Brooklyn and Richmond, a 36 inch flexible joint pipe is to be laid in a dredged trench across the narrows and covered with eight feet of silt. This will discharge into a large reservoir at Silver Lake which will make the southernmost terminal of the most wonderful water supply system in the world.

HIGH PRESSURE GAS FOR LIGHTING

High-pressure gas lighting has spread so rapidly abroad that surprise has been expressed that there has not been some progress here. A number of conditions, to be referred to later, are responsible for the unpopularity of the system in America, though undoubtedly plain inertia accounts to some extent for the neglect.

In the high-pressure scheme the pressure of the gas is raised from the normal of about 1.5 oz. to 2 lb. As a result, the temperature of the flame at the mantle is raised and the products of combustion are forced out more rapidly, resulting in an increase in efficiency—so far as volume of gas burned is concerned—of from 40 to as much as 100 per cent., depending on the lamp and the quality of gas. The reason for this great increase in efficiency can readily be appreciated from the fact that the light emitted by a mantle varies as the twelfth power of the absolute temperature.

The system naturally went through the usual stage of development and was placed on its present successful footing with the advent of the inverted type of mantle. Since 1907 its progress in application has been marvelous in England, Germany and France. Following its successful use in a large portion of the grounds of the Franco-British Exposition in London in 1908 came the rapid extension of the system for street lighting in various parts of London, until now a large part of the city of London proper is so lighted, as well as many important thoroughfares and squares.

Factory owners and commercial interests in England, moreover, have not been slow to recognize its advantages, its use by the former undoubtedly having been influenced by the industrial applications in which high-pressure gas is productive of special economies. In Birmingham a large high-pressure main has been put down, distributing gas over a large area at a pressure of 15 lb. per square inch, and while laid mainly for industrial purposes advantage is taken of it for high-pressure gas lighting, using the necessary reducing valves.

In Germany the progress has been only little slower than in England. In the city of Berlin, for example, there are not less than 40 miles of streets lighted by the new method.

Quite a number of other cities in Germany are using the system, and in at least one of them a variation has been adopted of supplying the gas at normal pressure, but of feeding compressed air to the burner. Apparently the latter scheme is proving satisfactory, though data permitting of a comparison with the usual method are not available.

In the United States applications have been limited to experimental installations—some six or eight in number—at the offices of gas companies.

The first cost of high-pressure lighting when gas is obtained—as it generally is in such installations—from a plant supplying domestic and other services at ordinary pressures is obviously an item of considerable importance. Not only are the lamps of special construction, but compressors must be installed, special devices or tanks supplied for preventing fluctuations from the compressor reaching the lamps, and separate piping run. Where the system has gained such popularity that a high-pressure main from the gas plant is warranted the system is much simplified. The general method of supplying the gas is to install a separate compressor for each group, the division into groups being based on the obvious factors of number and proximity of lights, cost of laying piping, etc. In London many shop fronts are lighted from such isolated systems, the consumer paying a fixed charge for the service, the lighting and extinguishing of the lamps being entirely in the hands of the gas company.

In the maintenance cost, too, high-pressure lighting is more expensive than low pressure, so that under any given set of conditions the saving in operation must be carefully compared with the increased installation and maintenance costs. Often the two practically balance. The more expensive the gas, the more likely is the high-pressure scheme to prove economical.—*Engineering Record*.

According to the new English coal mines act, a place shall not be deemed in a fit state for working if the air contains less than 19 per cent. oxygen or more than $1\frac{1}{4}$ per cent. carbon dioxide. The percentage of inflammable gas must not exceed 0.25 per cent. in an intake airway.

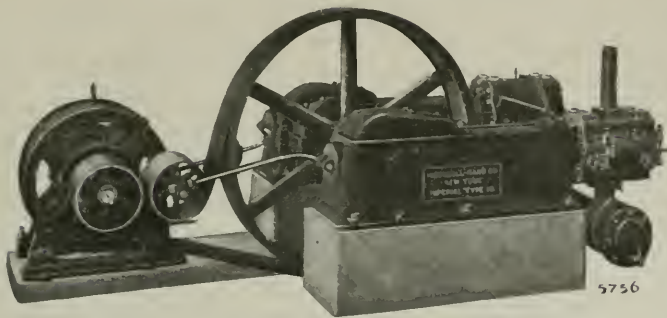


FIG. 1. COMPRESSOR DRIVEN WITH SHORT BELT.

COMPRESSORS IN CROWDED QUARTERS

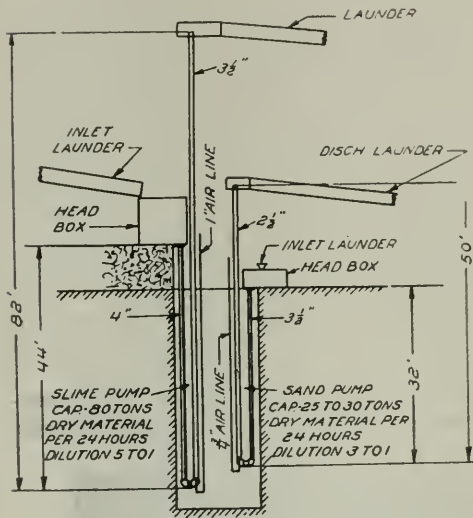
The view here given in Fig. 1, of a cross-compound, two-stage, short-belt-driven air compressor, carries little suggestion of the conditions which this type of machine is designed to meet and satisfy. For all that appears in the cut, it might be located in a spacious power house with ample room to get all around it; but as a matter of fact it is really designed to work in narrow quarters, and to accommodate itself to what, if a compressor had any feelings, would be a very uncomfortable situation, to say nothing of the contortions entailed upon the man in charge who might have to get around it.

A typical installation of a compressor of this type is shown—as much as the space would permit—in Fig. 2. This is an Ingersoll-Rand, B 2, cross-compound, two-stage compressor with air cylinders 20 and 11 in. diameter and 16 in. stroke, running at a normal speed of 150 r. p. m. and compressing 850 cu. ft. of free air per min. to a pressure of 150 lb. It is at the Humboldt (gold) Mine, Ouray, Colorado, and is located in a chamber which has been cut for it out of the solid rock 1200 feet under ground, which by the way, is still more than 500 feet above sea level. It is driven by a 150 H. P. Ft. Wayne motor, the short belt drive accomplishing at once the necessary speed reduction



FIG. 2. SHORT BELT DRIVE WHERE IT BELONGS.

and the minimizing of the space occupied. The pull of the belt is of course on the bottom and the floating idler fully guarantees the necessary tension. The compressor has been running nearly a year, giving perfect satisfaction and requiring no care except for the necessary lubrication. The compression is done economically and the air is delivered in as good condition as it could be if the compressor might have had its own choice of location.



AIR LIFT FOR SAND AND SLIME

In a mine in Mexico, where there was considerable trouble with other forms of pumps, the air lift was finally installed to handle the sand and the slimes from the mills. Two lifts were used, one with a $2\frac{1}{2}$ -in. lift pipe having 65 per cent. submergence, the tube discharge being lifted 18 ft. The other lift was a $3\frac{1}{2}$ -in. pipe with 54 per cent. submergence and an effective lift of 38 ft. It was thought best to have the well pipes of generous dimensions, and accordingly a $3\frac{1}{2}$ -in. well pipe was laid in the lower lift, and a 4-in. pipe in the larger one.

During two years they were looked at but once, and the repairs consisted of two nozzles and an 8-ft. length of $2\frac{1}{2}$ -in. pipe, for the two lifts. The lower or sand lift was plugged up at one time, but by closing the inlet or outlet and turning on high-pressure air the obstruction was easily removed. The

original air pressure as figured was 25 lb. per sq. in., but better results were had with 28 lb. The consumption of air varies from $2\frac{1}{2}$ to 3 cu. ft. for each cubic foot of sand or slime lifted depending on the dilution of the material. For the final lift of 38 ft., a minimum dilution of 5 to 1 is necessary to give good results. The lower or 18-ft. sand lift is run on a 3 to 1 dilution to avoid excessive handling of solution.—*Colo. School of Mines' Mag.*

GRAPHITE POWDER FOR AIR CYLINDER LUBRICATION

The Graphite Oils Co., Ltd., of Glasgow, are strongly against the use of oil in any form in the air cylinders of compressors, and to get over this difficulty they have manufactured a dry impalpable-deflocculated, air-blown-graphite powder, specially prepared for this purpose. They recommend that this dry graphite powder should be inserted in small quantities through the compressor suction inlet, and insist that the whole question of the lubrication of this part of the machinery is thereby solved. This method makes for entire safety and security from accidents, there being no danger of explosion through the accumulation of oil deposits, and no possibility of valves or cylinder faces being jammed by a carbon deposit with this form of lubrication. Another point in its favor is that it does not contaminate the compressed air which is conveyed and distributed to the various machines underground, the exhausts from which machines frequently vitiate the atmosphere of the mines.—*South African Mining Journal.*

OXYGENIZED ICE

Mr. George Leroy, director of the Ice Dealers' Society of the English Channel, Dieppe, reporting to a Committee of the French Association of Refrigeration, refers to the use of "oxygenized ice" as a conservation medium; the process being applicable to ice for refrigerating purposes only, without contact with food products. He states the process consists of adding peroxide of hydrogen or oxygenized water to the ice during its manufacture, the peroxide being incorporated by abrupt congealing. To distinguish such ice from the ordinary product, it is slightly tainted by carmen of indigo, blue methylene, etc. Besides refrigerating, this ice has antiseptic qualities.

ROCK DRILL DEVELOPMENTS*

BY W. L. SAUNDERS.

The following may be taken as a crude classification of the various types of rock drills in use to-day, the arrangement having nothing to do with the date of their successive adoption.

(1) The plugger drill. This is of the hammer type. It is used in its smallest sizes for dressing stone, for trimming, cutting hitches, and for block holes. It is a hand-rotated machine.

(2) The Jackhammer. A hammer drill with automatic rotation, used for sinking shafts, for down-hole work in stopes, for quarrying, for drilling in coal, and in rock and ore work wherever down-holes are required. It is held in the hand of the operator and in some mines is used for horizontal work, mounted upon some simple form of support.

(3) The stoper. A hammer drill with air feed, usually used without mounting and for up-holes. It has a large field of usefulness, mainly in stopes or rooms and in driving raises.

(4) The mounted hammer drill, as exemplified in the Leyner type, used mainly for horizontal, or approximately horizontal, hole drilling, for side stoping, and for driving drifts and tunnels. In this type of drill a combined stream of air and water is discharged through a hollow steel at the bottom of the drill hole.

(5) The reciprocating drill, used for heavy down-hole drilling where the stopes are large, and for surface work, drilling deep holes of large diameter.

In the last two or three years the study of rock drill economics has been pursued so vigorously and so successfully that in design, material, and workmanship the rock drill of to-day is a superior machine, doing more work, standing up to its work longer and better adapted to conditions heretofore unknown than the machines of the past. Lighter in weight, and more easily handled by the operator, it is an aid to the miner

in very materially reducing the cost of ore per unit of labor, repairs, and power consumption. There has in fact been an evolution in the rock drill from a piece of steel with a bit on the end of it, struck by the hand of an operator, to a similar piece of steel struck by a power hammer. Between these two extremes we have seen the jumper, the hand-operated drill, and the power-driven machine, which started with the cumbersome rock drill of J. J. Couch, about 1850, followed by the reciprocating machine of Joseph W. Fowle a few years later, Fowle's original idea of the cutting tool being an extension of the piston rod continuing to hold supremacy in many simplified forms up to a very recent period.

It is interesting to follow the evolution of the percussive type of rock drill. We must bear in mind that there are two distinct types of power-driven machines—the reciprocating and the hammer drill. Fowle's first machine was mounted upon wheels and weighed several thousand pounds. The Burleigh drill, which was a development of Fowle's invention, was a machine mounted either upon a carriage or a tripod, but in any case it was difficult to get the weight below a thousand pounds. The struggle to reduce the weight at first met with considerable success when air pressures of from 40 to 60 lb. were in vogue. It was found, however, that it paid in mining work to use high air pressures, and this at first interfered with the efforts made by engineers to bring down the weight. There was even a period, some 20 years ago, when some engineers advocated heavy rock drills as best and most efficient in the end. Successful contractors specified large machines, claiming that by their use they were able to increase the air pressure, to get a heavier blow, to save upkeep expenses and to reduce the cost of excavation. Heavy drills invariably called for heavy mountings, and here is where an added difficulty was experienced, because heavy mountings were cumbersome underground, they were in the way, it was necessary to employ more men to handle them and they could not be used at all in narrow places. Here began the struggle for supremacy between the percussive and the hammer types,—a struggle which has recently resulted in the adoption of the hammer type as the most useful drill for general mining purposes.

*A portion of a paper¹ (with some re-arrangement) presented at the Butte meeting, Aug., 1913, of the American Institute of Mining Engineers.

THE MODERN ROCK DRILL.

The mining drill at the present time is a machine which weighs from 60 to 150 lb. It is largely a one-man machine, though under many conditions of work it is still best to add a helper. The percussive or piston type still holds its supremacy for heavy work, even in mines where large stopes are encountered, as, for instance, at the Homestake, but this percussive drill is now a machine which safely withstands pressures of from 100 to 110 lb. and its weight has been considerably reduced because of changes made in both design and material. This type of drill now used in the stopes at the Homestake weighs 137 lb. unmounted, and mounted on column with arm about 375 lb. Its work is chiefly in down-holes. Each part of the machine represents a study in material. The metal itself and the treatment it receives in the shops are both regulated in accordance with the work that each particular part has to perform. All our knowledge of metallurgy is taken advantage of in the construction of the drill. The cast iron is not ordinary cast iron. It resembles it only in that the metal is cast. The composition is made up to suit rock-drill service and the metal is treated with special reference to the work it is to do. The steel is not common steel, but it is alloyed to suit each particular part. It receives a hot, crude oil bath and it goes through many processes before it is finally coupled up with the other parts into a complete drill. Special metal and special treatment are not confined to the piston or percussive type, but they apply equally to the hammer type. In fact, it was because of the necessity for lighter weight and greater strength in the hammer type that the study of the metallurgy of the rock drill was initiated and carried to a successful issue.

The first great improvement made in the piston or percussive type having been in the metal used, this has resulted in greater strength, greater durability, and a lighter weight of machine for higher pressures. There has also been a change in design, which in the main has been confined to the valve motion. The chief aim of the designer has been to get greater speed. This means a greater number of blows, and in order to do this valves have been provided which open and close quickly and which have large ports. It is obvious

that, other things being equal, a piston type of drill of large piston area will do more work than the same type of drill with a smaller area. The larger machine, which drills more, is handicapped by its weight, and when the net efficiency is figured up it has been found that it sometimes pays to get less drilling capacity with a machine which is more readily handled. Here the question of upkeep is introduced, because generally speaking the heavy type of machine costs less for repairs than the lighter type. The designer, taking all these things into consideration, has sought to increase the diameter of the piston so as to provide the drilling capacity of the heavy type with a machine of considerably less size and weight. This has in a measure been accomplished by the use of superior material and a design which shortens the piston, putting the extra bearing into the front head, where it is lighter. Through the use of a type of valve known as the butterfly a quick opening of large area is provided, thus increasing the number of strokes and thereby bringing up the drilling capacity. This has been done with no increase in air consumption that is not compensated for by increased drilling power.

Air consumption in rock drills is much misunderstood. Assuming that the piston and valves are tight, in other words, where there is no leakage, air consumption is usually dependent upon the number of strokes delivered. It is assumed, of course, that a constant diameter and length of stroke are used and that the pressure is uniform. It is plain that if we are able to utilize air or steam at 100 lb. gauge pressure for the full length of stroke, when a percussive drill delivers its blow we are going to get the best results in drilling capacity; that is, we are going to get the hardest blow that is commensurate with the diameter, length of stroke, and pressure of the machine. If this blow is too hard, that is, if it breaks the steel, destroys the bit, or creates a condition where the drill is unmanageable on its mounting, then we have the alternative of reducing the size of the machine and in this way getting lighter weight, which is always desirable when it is consistent with the other conditions. We all know that the class of rock usually determines whether or not we are striking too hard a blow, but assuming that the class of rock is uniform, or that it is determined and understood, the engineer is ob-

viously justified in providing a drill which will strike the hardest blow that the machine and the rock will stand without destructive consequences. We see, therefore, how important it is to start with a machine which has a valve motion and ports so designed that the full power pressure will follow the piston the full stroke until the blow is delivered. Having this condition, as light a machine should be used as will stand up to the work.

It naturally occurs to one that a quick-opening valve and a large port will bring about greater speed, but the question is asked, is not this condition wasteful in air consumption on the return or back stroke? It will be generally admitted that it pays to get the blow, but why should the same conditions that give us the blow obtain when the piston returns for another stroke? There are two reasons why this is advantageous. One is, that the pull-back on a piston type of rock drill is sometimes of as great importance in the long run as the blow. A weak pull-back reduces the speed of the machine, causing it to come back more slowly than it went forward, and it has the further disadvantage that holes that are not straight, or which are out of round, and where seams and other irregularities are encountered, will act to retard the steel during its reciprocations. This considerably reduces the efficiency of the machine, not only because it cuts down the number of blows delivered, but because it weakens the strength of blow. The steel is held back in its effort to reach the full stroke and a labored blow, with sometimes a shorter stroke, is the result.

Now it is quite true that in good, clean, hard rock, without seams, and where holes are drilled to reasonable depths, it might pay to save air on the return stroke. As a matter of fact, this is always done in a piston drill because the diameter of the rod must be subtracted from the piston area. The percussive piston type of drill is naturally a compounded machine which hits a harder blow forward than backward, because it has the full piston area at one end and a reduced area at the other. It is not a difficult matter to regulate this to any degree desired by increasing or decreasing the size of the piston rod or by increasing or decreasing the valve and port areas on one end of the stroke and not on the other. But every attempt to compound a piston type of drill by putting a pressure in front

of the piston is a mistake. Just in proportion as a measure is introduced in the front end it would cushion or restrict the force of blow, and in doing this, as has been previously pointed out, we make it necessary to increase the weight of the machine in order to get the effective maximum blow. It is, therefore, a very dangerous expedient in the design of piston drills to attempt to compound the stroke. Reduced air consumption is easily effected at the sacrifice of efficiency. Air at 100 lb. is delivered to a percussive drill at a cost that varies from 40c. to \$2 per day. To save 25 per cent. of this is all that compounding could reasonably be expected to accomplish, and this at the maximum is only 50c. a day. Experienced engineers will have no difficulty in seeing that there are many ways underground by which this and larger amounts may be lost through a machine which must inevitably be weakened in certain other directions in order to effect a small saving in air economy. Under most conditions of service it pays to conserve labor and upkeep expenses, giving first consideration to those things which cost most. A small reduction in drilling capacity, or a few idle hours, means an expense which will easily run in excess of any possible saving in air.

The hammer type of drill is a natural air saver, and it is in the design and construction of this type that air economies may be effected safely and without sacrifice. The hammer drill is essentially a machine for mines. It represents the evolution of the rock drill from the piece of steel struck by a hammer through the various stages of percussive machines back again to the hammer-driven blow upon the steel, the difference being only that the blow is a rapid power blow. A hammer drill is economical in air consumption because, in the first place, it reciprocates a light plunger which weighs only a few pounds, while with the piston drill not only must the heavy piston be thrown backward and forward at high speed, but it carries with it the steel and bit. In hammer drills the power is utilized, not in overcoming the inertia of a heavy body, but in compensating for that inertia through the high speed of a light body. A heavy mass moving slowly may give the same impact of blow as a light mass moving rapidly. The effective work done at the bottom of the hole is represented by the weight multiplied by the velocity. The same effect may be produced

by subtracting from the weight and adding to the velocity, or *vice versa*. In a piston or percussive drill, velocity is limited, while in a hammer drill it is practically unlimited, and here is where the great possibilities of hammer drills have come in.

We must always bear in mind in comparing piston and hammer drills that the piston drill is handicapped by the load of the piston and steel, which has a certain inertia difficult to overcome in our efforts to reach high speed. The stroke is necessarily short, and as the hole gets deeper this handicap of weight is increased by longer steels, so that we are driven to high air pressures in order to get high speed. High air pressures naturally cost more money than low air pressures, and, as has been shown, if we attempt to save air by compounding we limit the capacity of the drill to force itself through difficult places.

In holes at or near the horizontal there is always an added disadvantage in a percussive type of drill, due to the steel dragging in the hole. This will take place even in a clean, straight, round hole. The steel sags, and in sagging, and during the process of rotation, there is considerable friction loss within the hole. All this leads us to high pressures, which is only another expression for greater power. It is safe to say that the piston type of drill has reached its limit when we consider capacity as a limitation when rating efficiency. In down-hole service, especially for deep holes and in soft rocks, piston drills will always be useful. The pumping action of the bit serves to agitate the material at the bottom, especially when mixed with water, and in this way the hole is kept more or less clean under the bit.

HAMMER DRILLS.

The study of rock-drill economics has led the mechanical engineer into the hammer-drill field as one which offered the greater possibilities. The problem was to do more work and with a lighter machine. The next consideration was to accomplish this with a reduced labor and power cost. All of these conditions have been met and, as subsequent figures will show, extraordinary results have been obtained which have materially reduced the cost of excavating rock and ore. We have seen that the process has been one of return to primitive methods. In other words, we have done what is most natural; and that which

conforms closest to the laws of Nature is invariably best. The natural way to drill rock is to strike a piece of steel with a hammer. The only reason why the miner does not continue to do things in this way is because he cannot strike a sufficient number of blows. Just in proportion as he uses a heavier hammer does he reduce the number of blows that he is able to maintain and with the lighter hammer he is brought to an absolute limit. It would seem that the first thought of the engineer would have been to follow the old miner by building a rock drill on the hammer type. He may have thought of this, but the problem proved to be a very difficult one. The first difficulty was to get material that would stand up against this rapid-fire system. Then came the question of rotation, which was not easy to accomplish with a machine of the hammer design.

Of equal importance was the question of keeping the bottom of the hole clean, because the bit, being practically stationary at the bottom, the cuttings from the hole would pack between the edges of the bit and the bottom of the hole and prevent further progress. Jets of steam, of air, and of water were used to discharge the cuttings. Steam has many disadvantages, air is expensive and it creates dust, while water is, in the first place, difficult to introduce into the bottom of the hole, its mixture with parts of the drill results in wear and tear, and to use much water is a disadvantage and an expense in underground work. Up-hole work offers less difficulties for hammer-drill service than any other. The cuttings drop by gravity out of the hole and the only disadvantage is dust. Horizontal hole work is that which is most difficult, while with down-holes water thrown into the hole always serves a useful purpose. A mixture of air and water has solved most of the problems arising from the use of hammer drills in mines. This is known as the Leyner system. Air is always available and is readily conducted into the hole, using either live or exhaust air. Where this air is commingled with water it discharges the cuttings from the bottom of the hole without blowing them away in the form of dust, but by simply reducing them to a puddle condition with enough water only to create a moderate stream, which discharges the cuttings through the orifice of the hole. This keeps the bit cool, there is enough puff to the

air to remove the chips, and a long experience under all conditions of service has demonstrated conclusively that a mixture of air and water is more effective in cleaning the hole than even a large stream of water alone. In fact, air is the ideal thing to use, and it would be used alone were it not for the dust, so that the present system introduces only enough water to lay the dust. In doing this we effect economies by using only a small amount of water mixed with air from the exhaust.

The pneumatic tool, especially the type known as the riveter, illustrates the mechanical principles involved in the hammer drill. It is likely that the perfection of the pneumatic tool led to the perfection of the hammer drill. A riveter combines an extraordinary amount of power. Its efficiency is very high because the hammer speed is high, and the machine is light and easily handled. Its use in steel and iron construction is now universal. Air consumption in a tool of this nature is low in proportion to the work it does, because the thing reciprocated by the air is so light that it is easy to get high speed without sacrificing power to overcome inertia. In other words, there is a closer relation between the air pressure and the speed of hammer, with the resultant effective blow.

A point not to be lost sight of is that the rapid reciprocation of a flying piston, as in a hammer drill, is very much more easily mounted or held by an abutment than where we have a reciprocating action of a heavy weight, as in the case of a piston drill. The reasons for this are obvious. High speed of a light hammer takes the place of slow speed of a heavy hammer. One is like the rapid reciprocations of a hand hammer, the other the ponderous swing of a sledge. So great an effect is obtained by this rapid, light blow that it has been found practicable to reduce the weight to a figure considerably under 100 lb. in a machine which in drilling capacity compares favorably with a piston drill of two or three times the weight. In this light machine, material alone has not enabled us to cut down the weight, but the light rapidly moving piston design, with the quick-opening valve, is of equal importance. It would surprise a drill runner of 10 years ago to learn that hammer drills are used to-day in hard rock, putting in holes 10 and 15 ft. in depth without even mounting the drill, it being held in the

hand of the operator. Of equal importance in tunnel driving is the fact that by the use of hammer drills the equivalent of heavy machines is placed in the headings mounted upon a light horizontal bar, this bar being easily handled by a few men, yet it affords abutment enough to resist the jar, because the jar has been reduced to a minimum. Heavy upright columns, carriages, and other forms of support were made necessary because of the ponderous pulsations of the piston drill. To be able to use a light bar, placed horizontally, is of the greatest importance in tunnel driving because it affords an opportunity to begin drilling quickly after a blast and before the muck has been cleared away from the bottom of the heading.

An effort has been made in the foregoing statements to analyze and give reasons for a condition in rock-drill service which is now in practical operation. A hammer drill is the modern progressive miner. It has practically done away with hand drilling and in doing this it has largely increased the field of service. There is no longer any question about the fact that it pays to use power drills in all classes of mining. It is now entirely a question of adapting the system of mining to these light, efficient, handy perforators.

In August, 1912, there was held at Calumet, Mich., what is perhaps the last contest between hand and power drilling. A three-man double-jack team of the best drillers in the copper country were pitted for a money prize against a small hammer drill of the Butterfly type. This machine was operated by one man. The drilling was in a block of Cape Ann granite, 60 in. thick. The three-man drilling team started with a 1¼-in. bit and finished with a 7⁄8-in. bit. The one man with the Butterfly (this is a light hand hammer drill, of the usual plugger type, weighing about 40 lb.) used a 2-in. starter and finished with a 1¼-in. bit. It required 14 min. for the machine to drill entirely through the block (60 in.), while the hammer-and-drill squad put in a 49-in. hole in the same time. The machine thus did 20 per cent. more work with one-third the labor cost. As a matter of fact, no such rate of hand drilling as was shown by the three-man squad could be maintained over a working shift, while there is no reason why the machine drill should not keep up its speed indefinitely.

FUEL OIL SERVICE IN NAVY YARD FORGE SHOPS

F. G. Coburn, Assistant Naval Constructor, United States Navy Yard, Philadelphia, has written for the American Machinist an interesting account of the use of fuel oil in the navy yard of the United States. It is not only interesting but conveys valuable and reliable practical information concerning an important industrial development. The report is reproduced here in somewhat condensed form.

Those who have had experience with both coal and fuel oil as forge-shop fuels are agreed, practically without exception, that oil is far superior to coal. Water gas and producer gas are being thought of for this purpose, also pulverized coal, but the cost of any one of these is still prohibitive as compared with oil, and the cost of oil is still low enough to be attractive. So that for the present, and probably for some time to come, fuel oil must really be considered the ideal forge-shop fuel.

Fuel oil has had a broad field opened to it in the past ten years, and interest in the development of its use has been very general. This interest has been chiefly shown in the development of the oil furnace, not only for forging, but for a great many other purposes; so that a great many industries have been instrumental in working it out.

The United States navy yards have been closely connected with the development of oil burning, and have been very consistent in their adoption of it. All the navy yards now use fuel oil in their forge shops; in many of them to the complete exclusion of coal. The adaptation of fuel oil to the blacksmith's open forge is particularly a navy-yard development whose importance and value have not yet been thoroughly recognized by the commercial world.

DIFFERENT INSTALLATIONS.

No two of the navy yard installations are identical, and some of them differ widely from others. The differences between these installations show in a very plain way the different ideas as to how oil should be burned in the forge shop, and seem to point out to an investigator the ideal method.

In a general way, it may be stated that the differences in methods hinge on the method

of breaking up the oil and mixing it with air preparatory to burning it. This, of course, has to be done mechanically, either by the impact of air or steam jets, or by a spraying nozzle, relying on the pressure under which the oil is supplied, or by a combination of these methods.

If a spraying nozzle can be used, together with an air supply under fan pressure (6 to 8 oz.), the cheapest method results. This can be done readily in furnace installations, as is amply proved by experience; and where furnace installations only are required, no other method should be considered.

Where open forges, flanging forges, etc., are required, it has been found that this method is not satisfactory, because it is impracticable to break up the oil and burn it fast enough to heat with sufficient rapidity. One year ago this statement would have withstood any attack; but within this last year, at least one such installation, and perhaps two, have been developed with promises of success.

STEAM JET ABANDONED.

Experimental work and actual practice up to that time, however, had shown the necessity for positive and quick breaking up of the oil. This was at first done usually by a steam jet, but this practice was abandoned because of the expense of installation, waste of steam, and waste of heat applied to raising the temperature of the steam in the flame. It was also very noisy.

This method was early supplemented by the use of air at high pressures—usually near 100 lb.—for atomizing. This installation was quite as expensive to put in as the steam atomizer equipment, was just as noisy and just as expensive to operate, but it showed a saving in heat, because the air was applied for combustion. Neither of these methods is in good repute any more.

PRESENT METHODS OF BURNING OIL.

At present there are three well recognized methods of burning oil, using air, as follows: (A) A combination of an atomizing air jet of about 20 lb. pressure and a supply of air for combustion under low pressure (fan blast). (B) A medium pressure of air, about 4 lb., for atomizing and combustion. (C) A fan blast only. The last method is success-

ful for furnaces, and should be employed where furnaces only are in use. It is hoped that it will soon be successful for open forges. The first two methods are successful both for forges and furnaces.

Two general types of burner must be recognized in connection with the above: the closed type, Fig. 1, and the open type, Fig. 2. In the closed burner all air, whether for atomization of the oil, must come from fan or blower or compressor through the mains to the burner, and no other air may be admitted.

In the open burner the injector action of the burner is relied on to pull in enough air from the surrounding atmosphere, through suitable apertures, to provide, with the atomizing jet, for complete combustion of the oil. It must be apparent, all other things being equal, that the open type burner is better than the closed type, as it requires less power to compress its air. This power saving is nearly 50 per cent.

TYPES OF BURNERS ADOPTED.

About eight years ago the investigation of oil fuel for the open forge was taken up at the navy yards at Norfolk, Va., and Mare Island, Cal., and within a year oil fuel in the forge shop was a success at both places. At Norfolk a combination burner, type A., is used, a closed burner, taking compressed air at about 20 lb. for atomizing, fan blast for combustion, and oil at about 20 lb. pressure. At Mare Island a type B, open burner, was developed, taking air at about 4 lb. for atomization and partial combustion, the inspirator action serving to provide sufficient air to complete the combustion.

At the New York yard there still remain some forges using air at about 90 lb., but the furnaces are being arranged for fan blast, type C burners, as are the forges, the latter being in the nature of experiments. This yard has always been experimenting with oil fuel, and a great deal has been learned there. The oil installation there is not, however, quite so complete as at other yards. At the Portsmouth, N. H., navy yard a medium pressure, type B, closed burner, is in use, and its application is complete. All furnaces and forges, whether for solid, angle or plate work, use oil successfully.

At the Philadelphia navy yard the medium pressure, type B, open burner, is installed, and here again the oil installation is complete.

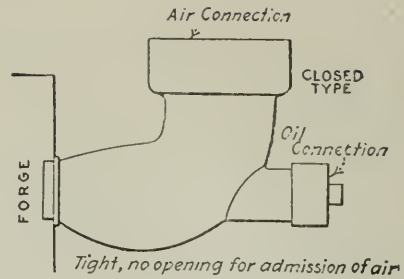


FIG. 1

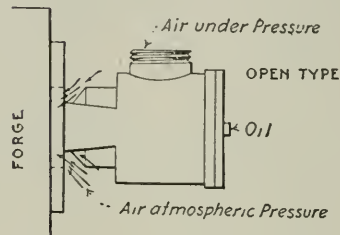


FIG. 2

TYPES OF BURNERS.

no coal fires for any purpose being used in the forge shop. This installation is in all essentials like that at the Mare Island yard, as is also that at Puget Sound, Wash., and all three are entirely successful. At the Boston yard the type A, or combustion burner, has found favor, so that the installation there is essentially the same as that at Norfolk.

In general it may be said that the navy yard experience indicates the desirability of the low pressure (type C) installation, and that it is successful now for furnaces, but when a large proportion of the work must be done at the open forge, as is the case in navy yard forge shops, some more positive methods must be used in order to get a sharp enough fire; and here the general opinion, as indicated by practice, points to a medium pressure, open type burner.

HANDLING THE OIL.

When the study of fuel oil was taken up, oil was very cheap, and a light gravity oil was obtainable. One of our largest Western railroads did, in fact, decide that it did not pay to use an oil heavier than 25 deg. Baumé. Thus, the Eastern yards met with no difficulties in handling the oil in the shop, in getting it to the burner ready to burn. They employed an arrangement similar to that shown diagrammatically in Fig. 3, which

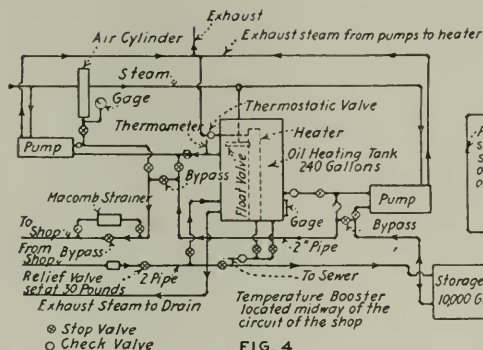


FIG. 4

OIL STORAGE.

consists of a large storage tank, a small auxiliary tank for measuring and settling, and a loop around the shop for the oil, air pressure serving to supply it.

But when the early work was started on the Pacific Coast, it was found that to burn the oil obtainable then, which ran 14 to 18 deg. Baumé, and had considerable water in it, a more complete system was needed. Fig. 4 shows, diagrammatically, the method that was developed. An auxiliary tank for settling and heating the oil (to make it limpid), with a circulating pump to keep hot oil moving through the mains constantly, comprises the apparatus. This circulating pump maintains a pressure of about 50 lb. in the oil line, the excess oil passing through a relief valve set at 40 or 45 lb., back into the settling tank, the level in which is maintained constant by a supply pump, controlled by a float valve in the tank. This arrangement is really less complicated than the diagram suggests.

Of late years, the fuel oil supplied to the Eastern navy yards has been heavier than at first, but the old oil installations worked satisfactorily enough because knowledge of burning oil has increased. However, I have found that the oil-heating and circulating system is worth putting in, even now, and I look to see it more generally adopted. The oil should be heated to not less than 140 deg. F., and booster heaters put in along the line to keep the temperature from getting below 120 deg. F., if practicable, as this gives the best results. At Mare Island and Philadelphia the arrangement shown in Fig. 4 is installed; the other yards are fitted out like Fig. 3.

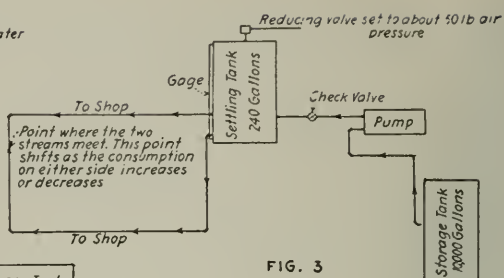


FIG. 3

AIR FEED FOR PNEUMATIC DRILL

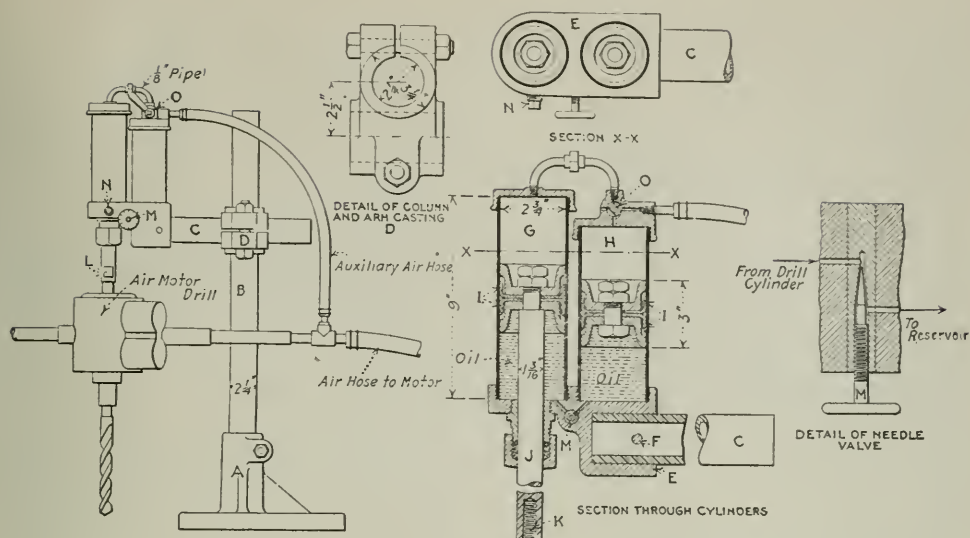
BY NELSON B. HENRY.

The feed mechanism and drill stand here described were designed to be used in connection with an ordinary air drill and is strictly a portable outfit.

The drill stand or "Old Man," consists of a base *A*, a column *B*, an arm *C*, and a clamp casting *D*. The arm and column are made of 2-in. hydraulic pipe finished on the outside to 2¼ in. diameter and of such lengths as may be required. The base is slotted and provided with a clamp bolt so that the column may readily be removed in case one of different length is necessary. The clamp casting also is slotted and has two clamp bolts, so that the drill may be adjusted as to height or the arm may be partially rotated for drilling at an angle.

A casting *E* is pressed on the end of the arm *C* and held in place by a pin *F*. This casting is recessed and threaded to receive the drill cylinder *G* and the reservoir cylinder *H*. Both cylinders are made of brass tubing such as is generally used for the working barrel of a deep-well pump. Each cylinder is closed at the top by a brass cap screwed in place.

Brass pistons fitted with double cup leathers *I* work in the cylinders. The piston in the drill cylinder is fitted with a 1⅞ in. steel rod *J*, internally threaded at the lower end *K* to receive the stud in the top of the air motor from which the hand feed star nut has been removed. Flats are cut in the rod at *L* so that a wrench can be applied in connecting up the air motor to the rod. The rod works through a brass stuffing box and nut at the



bottom of the cylinder as shown. The piston in the reservoir cylinder has no rod, being held together by a short bolt.

A four way valve *O* is made integral with the cap on the reservoir cylinder and serves to admit air under pressure at the top of either cylinder. An exhaust hole is drilled in the side of the valve so that when either cylinder is under pressure the other is open to the atmosphere.

In the casting which forms the bottom of the cylinders, and midway between them is a needle valve *M*. The valve casing is made of drawn brass rod and after being machined is pressed into place. Holes are drilled at an angle in the casting so as to intercept the valve casing above and below the seat. The valve proper is made with a very slight taper so that several turns of the hand wheel are necessary to open it appreciably. No stuffing-box is needed for the valve stem as the greatest pressure (from the drill cylinder) comes below the valve seat. The hand wheel is graduated so that it may be accurately readjusted to any desired opening of the valve.

The lower portion of the cylinders under the pistons is filled with a light oil such as is used by hydraulic jacks. Care must be taken to see that the proper quantity of oil is put in the cylinders or the full travel of the piston rod carrying the air motor will not be available. In order to do this, place the cylinders in an inverted position, push the pis-

ton rod to the top of the cylinder, open the needle valve *M* several turns and pour the oil slowly through the plugged hole *N*. When full, screw the plug in place and pull the piston rod as far out as possible. This will serve to shove the piston in *H* to the top of the cylinder. Now remove the plug *N* and continue to pull out the rod until the piston strikes the bottom, allowing the surplus oil to overflow. Replace the plug and the mechanism is ready for use. It is very important that no air be trapped in the cylinders under the pistons and the method of filling outlined above obviates this difficulty.

Connect the auxiliary air hose to the motor hose as shown. Turn on the air, start the motor and set the four-way valve so that the top of the cylinder *G* is under pressure. The piston in *G* will be forced downward, pushing the drill with it, at a rate of speed dependent upon the opening in the needle valve. It is, of course, obvious that the "feed" can be varied to suit conditions by opening or closing the needle valve. The oil escaping through the valve into the reservoir cylinder raises the piston therein. After a hole has been drilled, reversing the four-way valve causes the oil in *H* to be forced back into *G*, raising the drill out of the work. This last operation only takes a second or two if the needle valve is opened wide.

With the size of cylinder shown and 90 lb. air pressure, about 500 lb. may be applied

to force the drill into the work. The cylinders are designed to give a maximum travel of 6 in., although they can be made larger or longer to suit requirements.

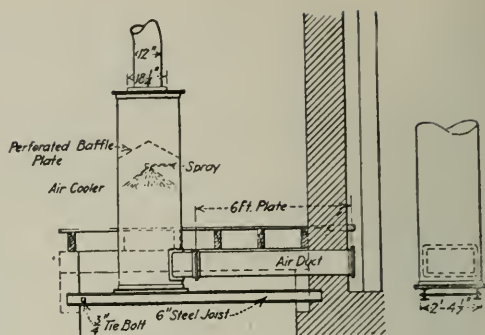
When reaming taper holes it is necessary to slow down the feed occasionally so as not to stall the motor when the reamer begins cutting along its entire length. The feed does not require the constant attention of the operator, and it may be depended on to keep the drill working up to its full capacity. As the motor is always supported by the oil, the drill will not gouge through and stop the motor when the hole is nearly completed as is often the case when the drill is fed by hand. The outfit is comparatively light and easy to set up. There is practically nothing except the cup leathers and packing to wear out and need repairing.

If the feed mechanism is always used in a vertical position or only slightly inclined, the piston in the reservoir cylinder may be omitted and the air pressure allowed to come directly on the surface of the oil when reversing the feed.—*American Machinist*.

A COMPRESSOR PRECOOLER AND AIR SCRUBBER

The illustration here reproduced from *Engineering and Mining Journal* shows a device employed by the Broken Hill South Silver Mining Company in Australia. It consists of a cylindrical upright cooling shell with a horizontal duct leading from the outside air; the duct is made of sheet steel and has a rectangular section. The free air enters at the right hand end of the duct and rising through the cooler is met by a downwardly directed spray of water from a cooling tower. The effect of this is to reduce the temperature of the air and at the same time to wash out all dust and foreign materials.

Getting the free air to the compressor, and into the compressor, as cool and as clean as possible, cannot be too much insisted upon, and the device here shown is to be commended, at least for the intention embodied, although it would seem to be hardly as efficient as it might be for the complete accomplishment of its purpose, and there is the additional objection that it would seem to be too elaborate and expensive, so much so that it might tend to deter some from precooling



and filtering their air when they surely ought to do so.

The apparatus as shown could not fail to have a good effect upon the air, but neither the cooling of the air nor the cleaning of it by the removal of the dust in suspension can be done instantaneously at one point of its flow for each operation as here indicated. If the upright shell had been entirely filled with some loosely packed porous material such as coke, and if there had been provided at the top a little stream of water sufficient to keep the coke constantly saturated, and if the air had been so piped as to flow up through the body of coke in a leisurely way it would have been cooled and well cleaned. It would be necessary to wash the coke occasionally by sending through it a strong stream of water, or the coke might require renewal.

But a much cheaper and a very effective device was described in *COMPRESSED AIR MAGAZINE* some time ago (June, 1911) and it would seem to be proper to again call attention to it. In this case there was a vertical pipe, of sufficient capacity to liberally supply the compressor intake, standing say a foot above the ground with a hood over it not interfering with the air flow but keeping things from dropping into it. This pipe was outside the compressor room and was continued under ground to connect with the compressor intake inside.

Well, over this pipe was set a wooden frame of cubical outline, measuring, say, a yard in each dimension and made of wood stuff about 2 in. square, and this was covered all over—except the bottom—with burlap, both inside the frame and outside, making two thicknesses of stuff for the air to pass through. To complete the rig there was suspended over it a revolving lawn sprinkler and a lit-

the stream of water sent through it kept all the burlap wet all the time.

This gave very satisfactory results and it happened to be located in one of the dustiest and hottest regions in the United States. When the burlap became choked with the dust, as frequently happened, the frame was lifted off and thoroughly soused, both inside and out, with water from a hose, which in a few minutes made it as good as new.

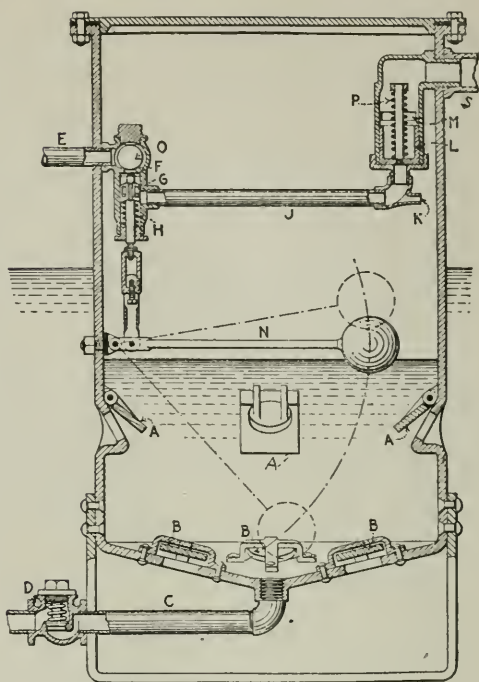
It scarcely needs to be remarked here that the dampening of the intake air by this or any other device has no effect upon the quantity of moisture in the air after compression and ready to be used, because in any case where air is compressed to six or eight atmospheres and recooled to normal temperature, it will have more water than it can carry, and arrangements must be made for draining it, or for allowing it, as we might say, to dry itself, which matter it is not necessary to discuss here, as the practice should be already familiar to our readers.

AN AUTOMATIC AIR OPERATED PUMP

The sketch here reproduced from *Power* shows the essential features of a pump of interesting design which has been in operation for some time in the mine of the Pittsburgh & Southwestern Coal Company, Avella, Pa. It is the invention of Edwin Chamberlin and A. M. Gardner, Avella, Pa., who have applied for a patent on the device.

The body of the pump is a vertical cylindrical tank adapted to be submerged, or partly submerged, in the water to be elevated. It is provided with water inlet valves A and B, four of each. A water discharge pipe C is connected to the bottom of the tank, and a spring-controlled check valve D prevents any return of the water.

Compressed air of sufficient pressure is admitted by pipe E, being normally held back from entering the chamber by the ball valve O upon the valve seat F. With things in the position shown in the sketch, the valves A and B being open, water may be assumed to be entering the chamber and the float and arm N is rising. As it rises to the dotted position, the adjustable upright connection H and Plunger G will lift valve O and air will rush into the chamber by pipe U and the opening K. This rush of compressed air will also raise valve L to cover ports M by which the



AUTOMATIC DIRECT AIR PRESSURE PUMP.

air in the chamber has been escaping to the atmosphere, leaving by the pipe S.

The filling of the chamber with compressed air will drive the water down and out, the float falling as the water recedes and when it has fallen to about the position indicated in the sketch valve O will again be seated and the admission of air will cease, while the water will continue to be driven out by the expansion of the air in the chamber. When the pressure has fallen so that no more water is expelled the same decrease of pressure will allow valve L to descend, uncovering ports M and discharging the air to the atmosphere until all surplus pressure is lost when the tank will begin to fill with water, the above recited cycle of operations will be repeated, and so on continuously.

It would seem that the best that can be said of the above described device is that it will actually work. Some inventions will not even do that. The filling and emptying of the large chamber with compressed air, only a small part of the pressure of which can be availed of, entails a great waste of air. This

can be minimized by the proper adjustment of the float-controlled movements, but these apparently can only be changed by the removal of the big cover, which is an operation not inviting frequent repetition. When valve O is first lifted and before the ports M can be covered there must be opportunity for some air to blow through without doing any work at all.

ACTUAL EFFICIENCIES IN ROCK DRILLING

BY LETSON BALLIET.*

But little attention has been given to the actual time that pneumatic rock drills are cutting the rock. Careful investigation of the actual time that rock drills are using air brings forth some very startling figures. In fact, I may say they are actual surprises. The most startling fact is that the drills are cutting, using air, only about one-third of the time. There are places in hard rock, where a drill will stand and pound for more than one-third of the time, but there are other places where time will be lost to make up for it. Any period of three or six months, with a flow meter on the air will show but little variation from the tabulated figures.

"Lost lights," candles blown out by drill exhausts, or by leaking hose, or leaking connections, or when blowing holes, or put out by dripping water, or by being dropped, is variable but can safely be estimated at 2 to 3 per cent. of the time, when counted by the month. "Stuck drills" is variable loss of time, and might be estimated as reducing it another 3 per cent. though, in some ground, there is very little loss from this cause, while in other places there is considerable. In making the above figures in the table we were making our primary attempt at getting drill data, and since making them several points for study have arisen in our minds.

In making the table of figures herewith, the author took as a basis the wage scale at Tonopah, Nevada, which is \$4.50 per 8-hour shift for machine drillers, if the mine is dry, and \$5, if it is wet. Including the lost time of going in and coming out on company time, and the average between \$4.50 and \$5 per day, it is fair to assume that drill runners' pay in Tonopah, is practically one cent per minute—

as 8 hours of sixty minutes each contain but 480 working minutes for the shift. Therefore, to adapt these figures to other wage scales, it is only necessary to reduce the wage scale to "pay per minute" for drill runners.

Work—	Per		
	Time.	Cent. of	
	Minutes.	Time.	Cost.
Setting up machines.....	82	17	\$0.82
Shifting machines	66	14	.66
Changing steel	75	15	.75
Morning and noon starting.	24	5	.24
Oiling and cleaning.....	15	3	.15
Getting steel and water....	15	3	.15
Tearing down and blasting..	45	9	.45
Actual time drilling.....	158	34	1.58
Total, 8 hours, or.....	480	100	\$4.80

In the above table we have computed only one man to each drill, whereas, if more than one man is employed, the cost would be increased by the additional man or men. Muckers, trammers and compressor operator are not included in these figures. These figures were made with the mine operated by two shifts of eight hours each, allowing four hours between shifts for blowing smoke. If a mine is operated with three shifts, 5 per cent. additional loss is necessary for time to "eat on shift, get a drink and get started again" and 6 per cent. will be lost "blowing smoke."

Thus, on a two-shift basis, little more than 2 hours actual drilling can be depended upon, while considerably less than 2 hours can be credited when three shifts are employed.

It must be remembered that no criticism nor complaint can be charged to the miner, or drill runner, for in the above table we have given him credit for a full 480 minutes, doing something. We haven't charged the miner with a single minute of soldiering, nor wasting any time. He is working, doing all he can do, and if the drill operation is inefficient it is not his fault. Look at the table, and notice that "going to the end of the air pipe for air" and "rolling cigarettes" is not mentioned. If there is a fault or criticism to fall on any one's shoulder, because drills are inefficient, it is to fall upon the "engineering head" that planned the method of working and not upon the laborer who is doing the best he can with the equipment that is furnished him.

*Buckeye Mine, Tonopah, Nevada.

The loss, of 66 per cent. efficiency in machine drilling is not confined to the loss necessary in paying men to do "dead work" on a drill, or the pay roll loss to the miner, it goes clear back into your power bills, superintendence, interest on out-laid capital, and overhead costs. For example, let us assume, on a basis of 4 cent per kilowatt-hour for electric power, that it cost 90 cents per hour to keep a compressor running, to carry two ordinary drifting piston machines running. On the basis of $2\frac{1}{2}$ hours efficiency out of eight, the compressor cost \$7.20 a shift to keep running, whereas the drills use only \$2.25 worth of the power time. It is evident that \$4.95 has been donated to the power company, but the power company is not to blame. Manifestly, this loss is not up to the power companies, nor to the manufacturers of drills, nor to the manufacturer of compressors, nor to the laborer. Any big mine could well offer a reward, or bonus, for a plan that would increase the drill efficiencies. There is no chance for the responsibility of this inefficiency to be shifted; it is up to the engineering head, and management of each individual mine.

The question now arises "How can the efficiency of drilling be increased?"

First—Be sure that the drillers have a clean set-up. Muckers can clean out, so that \$4.50 and \$5-a-day-men don't have to do \$4-laborer's work.

Second—Give the men good ventilation, so that they will not have to go to the end of the air pipe for a breath of air, and so that they can work without becoming fatigued and exhausted at the slightest exertion.

Third—Provide them with good cool drinking water, so that they will not have to go clear to the station for a drink of water that may then be luke-warm.

Fourth—Provide them with drilling water, and necessary lubricants so that they will not have to be leaving the face to procure them.

Fifth—Provide them with plenty of steel and tools, so that they don't have to use dull steel, nor rustle tools, or wait for steel or tools.

Sixth—Last and not least, give them good light to work by. Electric lights, if possible. It pays. They can see to handle their machine, see to shift it, see to change steel, and see their work. They can take advantage

of rock if they can see it, and will be safe because they can see insecure roofs, walls and timbers better. If they go to the station for a drink of water, they will save time if they walk through electric lighted drifts and cross-cuts, for they unconsciously walk faster, than when groping along trying to keep a candle a'ight.

The writer, when sinking a wet shaft with machine drills, secured two storage batteries and made a galvanized iron box with a cover to keep out dropping water, in which he set a battery. This box had an automobile head light on the underside pointing down, and the sides of the box were equipped with hangers like a sinking pump, to hop over a wall plate or center piece. These batteries burned 6-volt lamps, weighed about 40 pounds, and run (burning) for 33 hours. These batteries in the housing were taken down every shift and hung on a timber up the shaft 15 feet or so from the bottom, and thus the bottom was flooded with light equal to the headlight of any automobile.

Thus the miners were able to see their work, in a brilliant light hanging in the man-way. Exhaust air for ventilation didn't put out the lights, dripping water didn't leave them in the dark, and the men themselves said that this light saved each man more than two hours a day fooling with lost lights. Men would rather work in good light than to be groping in the dark; if you don't believe it, just listen to the profanity generated when they lose their lights. In conclusion, I want to urge the importance of good light and good ventilation, for mine efficiency. Don't kick, and don't blame the men for not getting out the rock if you don't give them a chance.

MODERN ROCK EXCAVATION DEVELOPMENTS

The construction of such works as the Catskill Aqueduct, the Panama Canal, and numerous mines and tunnels throughout the world would be almost if not quite impossible were it not for the advantage which modern men have in the use of powerful explosives.

"Gunpowder as an explosive agent was not known in western Europe until a few years before the discovery of America; and it was not until nearly 150 years later that drill holes, loaded with this explosive, were used for breaking rock in the mines in Germany. This

method was soon after introduced into England, Sweden and other countries. The practice of land drilling and loading with gunpowder was standard up to within 50 years ago, although this seems almost incredible in view of the rapid strides made since then.

"Within the last half century the whole procedure has been completely revolutionized by the invention and development of three fundamental requisites—the air compressor, the power drill and dynamite."

And these means came into industrial practice very nearly at the same time.—*Catskill Water System News*, No. 45.

OXYGEN BLAST FURNACE PRACTICE.

BY GUSTAVE TRASENSTER,

(Ougrée-Marihay, Belgium).*

For some time past the Ougrée-Marihay Company has been carrying out experiments on the use of oxygen in metallurgy, with special reference to blast furnace practice. In order to obtain the oxygen required the company has had recourse to the air liquefaction process, deeming that, in the present state of the science, this was the only process which could be regarded as capable of yielding, in commercial quantities and sufficiently cheaply, the large amounts of oxygen that it was necessary to employ.

The system adopted at Ougrée for the liquefaction of air and its separation into its elements is that of Georges Claude, of Paris, in which liquefaction is obtained by means of great cold resulting from expansion, on doing work outside. This expansion, incomparably more efficacious than any other, is obtained with the greatest ease by driving, by means of compressed air, an expansion vessel—simply a piston working in a cylinder, very much like an ordinary steam piston. At Ougrée the pressure required for the compressed air is 15 atmospheres (say, 220 lbs. per sq. in.)

This method of expansion, in spite of its efficaciousness, is incapable of refrigerating the air to a temperature sufficiently low for its liquefaction in a single stroke; and it is by means of what may be described as a temperature transformer that the air escaping from the expansion cylinder by a tube concentric to

that by which it is admitted, is able rapidly to attain the temperature of liquefaction.

The liquid air having been obtained, advantage is taken in the process described of the difference between the boiling points of liquid oxygen and liquid nitrogen to separate the two elements. The boiling point of oxygen is—180 deg. C., and that of nitrogen—195 deg. C. This separation, however, necessitates boiling the mixture, and this is effected very easily in a vaporiser; the gases resulting from the ebullition rising in a receiver, the sides of which are sprayed by intensely cold liquids—mixtures of more or less liquid oxygen and nitrogen—which effect condensation and, as a result, the almost complete separation of the oxygen in the ascending gases. Thanks to this arrangement, the apparatus allows of pure gaseous oxygen being obtained on the one hand, and, on the other, equally pure nitrogen containing at most a few hundredths of oxygen.

THE OXYGEN PLANT AT OUGREE.

This plant is capable of making 600 cubic metres of oxygen per hour. It is composed of three absolutely similar liquid-air units, each unit yielding 7,000 cub. ft. of oxygen hourly. A unit consists of:—(1) A compressor, capable of drawing in 42,000 cub. ft. of air per hour, and of compressing it at a pressure of 220 lbs. per sq. in. This compressor is belt-driven from a dynamo. (2) A liquid-air machine and tower, containing all the fittings and appliances necessary for the liquefaction and separation of the air into oxygen and nitrogen. (3) Two decarbonizing towers. It is, as a matter of fact, of prime necessity that the air drawn in by the compressors and sent into the liquid-air machine should have every trace of carbon dioxide it contains removed. With this object the air is made to pass through two towers containing brick chequerwork, which is sprinkled with a solution containing soda. (4) A battery of desiccators intended to remove any moisture contained in the air. This battery is interpolated between the compressors and the liquid-air machine, and therefore receives the air under pressure. The desiccation is effected by means of calcium chloride.

The operations are of the simplest description, and the staff is very small. The manufacture of oxygen from liquid air has become a thoroughly practical and business operation; .

*Brussels Meeting of the Iron and Steel Institute.

and thanks to certain improvements with which the Ougrée machinery is equipped, it has been possible to secure continuous working.

The energy required is slightly over one horse-power for every cubic metre (35.3 cub. ft.) of oxygen. It is not possible, however, to base calculations on this figure, which, if anything, is rather too high, as, for a permanent installation, machines of larger capacity than 7,000 cub. ft. of oxygen per hour would be used. The power absorbed by a cubic metre of oxygen would diminish the larger the machines, and the makers are at present engaged in making machines to produce 35,000 cub. ft. of oxygen per hour. In these circumstances, and with the further improvements which will be made, it may even now be prophesied that with such machines the power consumption per cubic metre will fall to two-thirds of a horse-power.

EXPERIMENTS OF THE OUGREE COMPANY.

Some months ago a preliminary trial was carried out, but its duration was too short to justify conclusions being drawn. Owing to a set of circumstances quite distinct from the ultimate object of the experiments, this preliminary trial had to be discontinued, but it will shortly be resumed.

The experiments which it is proposed to carry out relate to two distinct problems:— (1) The first series of experiments will consist simply and solely of enriching the blast delivered to one of the Company's existing blast furnaces, by oxygen—that is to say, mixing with the blast for this blast furnace the 21,000 cub. ft. of oxygen available. The percentage of oxygen in the blast will be raised by these means from 20.8 to about 23 per cent. The problem to be solved is whether this degree of enrichment is sufficient to cause the anticipated phenomena to manifest themselves sufficiently distinctly. (2) Other experiments will be carried out in a small blast furnace which has been built and in which working will be carried out with very high percentages of oxygen, and even with pure oxygen. In the latter instance, should the need of so doing be felt, recourse will be had to the Oscar Loiseau process, and the intense heat will be reduced by introducing some of the waste gases at the hearth, so that, in any case, the reducing atmosphere in the furnace will be entirely free from nitrogen.

With regard to the results that may be expected, but without too rigidly anticipating effects or entering into theoretical speculations, it may be said that a reduced consumption of fuel, greater speed in the working of the furnace, and increased purity in the products may be looked for. So far as the power consumption in the manufacture of oxygen is concerned, the more highly the blast is super-oxygenized the smaller will be the volume it will be necessary to heat. On the other hand, although only actual experiment can decide the point, it may be necessary to heat the blast to a lesser degree. There would, therefore, be a certain amount of waste gas available. If it be found possible to work with pure oxygen it will not be necessary to heat the blast, in which case the gases available will supply considerably more motive power than will be required for the production of the oxygen.

To this must be added that enormous quantities of nitrogen will be available, the utilization of which will more than defray the expenses involved in the manufacture of the oxygen.

JACKHAMER DRILLS FOR FOOTWALL WORK ON THE RAND

The following report of work done on the Witwatersrand and G.M. Co., Ltd., shows what can be done with small hand machines when there is scarcity of native labour. Six Ingersoll B.C.-23 hand rotation jackhamers ran on the Witwatersrand G.M. Co., Ltd., for five months from July to December, 1912, continuously, taking up footwall in hard bastard rock. The method of handling the drills was to allow one drill, weight 54 lbs. per native, on contract at 1d. per foot drilled, with one jumper carrier and a white boss on each three machines. The average footage obtained per drill per eight hours' shift was 28.7 feet, the average depth of hole drilled being four feet, the most suitable to the mine's working condition. These six drills have been responsible for 150 tons of footwall broken per day during the period. This includes block holding or re-drilling broken rock, which was too big for handling. The mine authorities express themselves completely satisfied with the work done, which is peculiarly significant in view of the present shortage of native labor.—*South African Mining Journal*.

PERFORMANCE OF THE JACKHAMER IN BUTTE SHAFTS

The "jackhamer" drill is becoming increasingly popular for shaft sinking in Butte, where the rock is favorable (A. I. M. E. Bulletin, August, 1913). It is found that in either too soft or too hard ground, however, certain difficulties are encountered. In soft grounds the holes are likely to plug. Difficulty from this source is made less serious at the Pitts-mont mine by placing a hole sidewise in the steel about 1 in. from the end of the bit, so that if the end hole becomes plugged the air, passing out through the side hole, keeps the drill-hole clean above the last inch of the drill. In soft rock the drill bits are enlarged so as to take 1¼-in. sticks of powder; but in hard rock if the bits are so enlarged, drilling is too slow, and when not enlarged the smaller powder will not break the bottom clean. It is suggested that a more powerful drill of the "Jackhamer" type might prove satisfactory in hard rock.

TEST OF PNEUMATIC ASH-HANDLING

An official test of a pneumatic ash handling at a Chicago pumping station is described in a department report for 1912. The system comprises a Green rotary positive pressure blower and an 8 in. conveyor pipe, which carries the ashes from flat hoppers in front of the seven boilers in the station to the separator tank, from which point an 18-in. exhaust pipe leads to the dust collector. The conveyor duct consists of 212 ft. 6 in. of horizontal pipe, 45 ft. 6 in. of vertical pipe and four 90-deg. elbows of 15-in. radius.

When the test was made the ashes were first weighed and were then hoed into the opening of the conveyor. At boiler No. 2 655 lb. of ash were fed into the conveyor in two minutes, which is at the rate of 327 lb. a minute. As these ashes weighed 44 lb. per cubic foot, and as the boiler is at the far end of the conveyor pipe, several seconds elapsed before they were carried through. At boiler No. 6 the ashes were lighter, averaging 38 lb. per cubic foot: 894 lb. of this ash were fed to the conveyor in two minutes and fifty-five seconds, and were at once carried through.

Liquid hydrogen is the lightest liquid known to science; its density being only one-fourteenth that of water.

THE EVERLASTING MINE PUMP

BY BERTON BRALEY.

I chug and chug the whole day through
As faithful as I "oughter,"
I always have my work to do
To clear the mine of water.

The mine cars rattle to and fro
In noisest endeavor,
But mine cars come and mine cars go
While I go on forever.

By day and night, by night and day
My valves have throbbed and thudded,
And I must keep right on that way
Lest all the mine be flooded.

The cage may sometimes quit the job
And men can use the ladder,
But if for long I ceased to throb
Few breakdowns could be sadder.

But I am here to stop the flow
With strength that wearies never,
And while the cages come and go,
Still I go on forever.

The miners dig the buried coal
Whatever depth it lurk in,
But I must see the "deep black hole"
Is dry enough to work in.

For if they had to swim I know
'Twould bother their endeavor—
So miners come and miners go
But I go on forever.

I am not "fair to outward view"
I never was a beauty.
My lines of loveliness are few,
I'm built for heavy duty.

I know my humble job, and so
I make my best endeavor,
For men and mules may come and go,
But I go on forever.

New methods supplement the old,
New tools and new inventions,
New men the reins of power hold,
The mine has new dimensions.

I note how wise the bosses grow
How up-to-date and clever,
But men and methods come and go
While I go on forever.

—Coal Age

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IMPORTANCE OF ROCK DRILLING*

BY W. L. SAUNDERS.

It has been estimated that the value of the mineral product of the United States is about \$2,000,000,000 a year; that about \$25,000,000 is expended annually for explosives and that about double this sum is paid in wages where blasting is done. The value of the mineral products does not adequately express the importance of the industry involved in the excavation of rock and ore because of the enormous sums of money expended in tunnel driving, in quarries, and in open-cut excavation generally. We know that the Catskill Aqueduct in the neighborhood of New York, which is now nearing completion, has cost some \$165,000,000 and that about one-third of this may be rated at rock excavation. These illustrations are given in order to call attention to the great importance of an industry the extension and development of which in our industrial life depend so much upon the economics of rock drilling.

Reference has been made to the new Catskill Aqueduct. There are three aqueducts leading into New York, each built at periods separated by some 20 years of time. The first one, known as the Old Aqueduct, conveys the waters of the Croton river to New York City in a manner which reminds one of the old Roman aqueducts, the ruins of which are still in evidence. The engineers who laid out these old conduits sought to direct their lines around the hills and into the valleys, at all times avoiding the rock. When it was necessary to cross a river or a deep ravine, a bridge or causeway was constructed. High Bridge, over the Harlem river, is an arched masonry viaduct differing in no essential features from the aqueducts of the Romans. When the second Croton Aqueduct was built, about the year 1890, the art of drilling rock had been so far perfected, and the use of explosives, through the invention of dynamite, had become so general, that this waterway was planned and executed on straight lines, following rather than avoiding the rock. The second Croton Aqueduct is a tunnel through rock, about 32 miles in length; material gneiss, almost as hard as granite. Its

*From "Rock Drilling Economics," presented at the Butte meeting of the American Institute of Mining Engineers.

construction was made practicable by sinking shafts about one mile apart, thus providing multiple points of attack and also serving to ventilate the headings. This second aqueduct siphoned the water underneath the Harlem river. This 32-mile tunnel was built in five years. The Catskill Aqueduct, now nearing completion, not only followed the rock wherever it was available, but it passed under several rivers and actually conducts its water underneath the Hudson, where solid rock was sought and found at a depth of a quarter of a mile below the surface.

Pliny gives us a description of what, so far as we know, was the first long tunnel driven in the history of the world. This tunnel was about 3.5 miles long and from 6 to 10 ft. in diameter. Forty shafts were sunk in order to expedite the work, and it is said that 30,000 men were employed for 11 years in its construction. The fact that this tunnel and most of the ancient tunnels in the vicinity of Rome were driven through lime rock enables us to understand how it was even possible to build them. Limestone is the easiest material to perforate, and it is likely that here the ancient system of "firing" was used. Firing consisted of building a wood fire close to the rock and throwing water against the hot surfaces, causing them to flake. With lime rock the material would very likely be softened so that chisels might be used to advantage.

What is true of aqueducts is also true of railway tunnels and mines. The Hoosac Tunnel in Massachusetts developed, though it did not perfect, the rock drill. It was said after the completion of this work that only the treasury of a State made it possible to drive this tunnel by machinery. Had the mechanical engineer neglected the study of rock drill economics it is doubtful that any further attempts would have been made to drive hard rock tunnels by machinery, but the Hoosac was followed by the Musconetcong, driven from portal to portal by machinery. Then we have the Palisades, the Cascade, the Busk, and numerous other large railway tunnels made possible because the rock drill had been simplified and made efficient. In Europe the great Alpine tunnels, known as the St. Gothard, Arlberg, Simplon and Loetschberg, one of them (the Simplon) being a continuous tunnel without shafts for a distance of 12.25

miles, were made practicable by the efficiency of the rock drill.

We seldom stop to think how important the rock drill has been in our industrial progress. Dr. Raymond has said that it is the foundation of all the work of the mining engineer. Railroads, even in America, might have successfully followed the foot-hills and hand drilling might have been the feeble substitute for the rock drill in leading through impassible barriers, but railway efficiency would have fallen far short of its present status and the cost of transportation by rail would have been greater than it is at present. In this we are able to see that the civil engineer might possibly have survived without rock drill economics, but not so with the mining engineer. The history of modern mining engineering is closely related to the history of progress in the art of building a rock drill. Our so-called precious metals would have been indeed precious without this valuable auxiliary. The wealth of the world, especially in its gold, silver, copper, zinc, lead and tin, would have been enormously curtailed, limited by an inability to increase the output in proportion to the demand, and further limited by the fact that low grade propositions could not have been worked at all. Examples of this are seen in the Homestake, the Alaska Treadwell, the mines of South Africa, and in most of the important mines of Michigan, which though once high grade are now low grade properties.

W. L. S.

SELECTION AND TREATMENT OF STEEL FOR ROCK DRILLS

The following we abstract from a report, published by the Mines Trials Committee of Johannesburg, South Africa, of a series of investigations made by Mr. Robert Allen upon rock drill steels, the object being to determine the most suitable steel for use on the Rand and to standardize its heat treatment and manipulation.

It was formerly accepted as an axiom that high-carbon steels were the most suitable for rock drills, but Mr. Allen claims that while both of these and alloy steels require a more complicated heat treatment, their drilling results were no better than those of the ordinary medium-carbon steels. Low-carbon steels were eliminated for obvious reasons,

and from the ordinary medium-carbon steels were eliminated those that possessed undesirable tendencies, such as flaking, chipping, splitting, undue wear, or if they were generally treacherous. From the analyses of the most efficient steels remaining were deduced formulas for the compositions of the most suitable steels for rock drill purposes. In these formulas the carbon content varies inversely with the size of the steel as follows, this being one of the most interesting discoveries of the investigation:—(a) Larger than 1½ in. cruciform, or steel weighing more than 5½ lbs. per foot run, from 0.60 to 0.65 per cent.; (b) 1½ in. cruciform, or steel of equivalent weight, from 0.64 to 0.69 per cent.; (c) 1 in. octagonal, from 0.67 to 0.72 per cent.; (d) ¾ in. octagonal, from 0.70 to 0.75 per cent. The quantities of silicon, phosphorus, sulphur, and manganese recommended are the same for all sizes of steel, and are as follows:—Silicon, between 0.05 and 0.15 per cent.; manganese between 0.25 and 0.35 per cent.; the total manganese and silicon content not to exceed 0.40 per cent.; total phosphorus and sulphur not over 0.035 per cent., the less the better; alloying element none, except that aluminum might be used as a purifier so long as, in the finished steel, the amount did not exceed 0.10 per cent. As there appeared, from the experiments, to be no practical difference between steels of the same chemical composition, whether made by the open-hearth, the crucible, the Swedish-Bessemer, or the electric-crucible processes, the method of manufacture was optional. Hammered steel showed no superiority over rolled, therefore for rock drill purposes the expense of hammering might be avoided.

For the heat-treatment in the forging and sharpening of drill bits, oil furnaces were found to be superior to coal forges, and an oil furnace specially designed by Mr. Allen was found to give better results. The steels of the compositions recommended above can be heat-treated in a comparatively simple way, which makes a separate tempering operation unnecessary. This method is recommended, and is here given *in extenso*:—(1) The drills, properly cleaned, are heated to an orange-red heat, at about 1,050 deg. C. (1,920 F.), this heat extending a short distance along the drill from the cutting edge—about 1½ in. for a hand drill, 2 in. for a medium-sized machine drill, and 3 in. for a large ma-

chine drill. (2) The heated drill is then forged by rapid hammering and dollying, until it has reached a dull red color—about 600 deg. C. (1,110 F.)—the work proceeding as quickly as possible. This operation for a medium machine bit should be taken from about 45 to 60 seconds. (3) The bit, without letting it cool further, is put back into the furnace and reheated to a bright red color—about 950 deg. C. (1,740 F.)—the heat extending along the bit the same distance as before. (4) It is then sharpened and made to gauge, the hammering proceeding strongly and rapidly, until the bit has reached a cherry red color—about 750 deg. C. (1,380 F.)—the color extending in the case of a medium machine bit, when it is quenched. This operation, with a medium machine bit—in the hands of a good tool-smith accustomed to gauging—will take about 43 seconds. Bits made of 1½ in. cruciform steel or larger should be quenched by standing them vertically on a knife-edge support in the water in the quenching bath, so that the drills stand in from ½ in. to ⅝ in. of water. Smaller bits may be quenched by plunging them vertically into the water, and keeping them moving around in a vertical position for five or six seconds, and then standing the drills on the false bottom of the quenching bath and leaving them there until they have become of the same temperature as the water. The removal of a drill from the quenching bath before it is quite cold is liable to produce fracture.

The standardization of the shapes of bits, and the gauging of the bits in both directions, when sharpening drills, are considered important. The expense of sharpening is slightly increased, but this is offset by many advantages; the rate of drilling is increased; the miner's waste of time in selecting drills that he thinks will follow one another properly (but often don't) is avoided; the chance of "fitchering" or deflection of a drill by "slips" in the rock is reduced; also, when the reaming is good, the drill holes can be drilled more cylindrically and explosives used more economically. All the bits used during the experiments were made and sharpened by hand, and it is to be regretted that the investigations did not embrace experiments in the use of machine-sharpened drills, which are automatically gauged. It is pointed out that by close attention to what are usually considered trivial matters many economics can

be gradually effected. When the steel is of suitable composition, lighter drills can be used to bore holes of the same depth; this, in turn, allows the use of lighter drilling machines; less steel has to be handled and sharpened; less compressed air is needed. Incidentally, it might be noted that the use of lighter drilling machines lessens the number of helpers required.

WELDING SUPERSEDING RIVETING

Flame welding is slowly coming into use in our shops, though not in a way to attract special attention as a shop process with great possibilities. But the visitor to some German machine shops begins to be impressed with the idea that riveting and soldering as means of fastening together two pieces of metal are fast passing away.

Not only is flame welding used for the operations with which we are familiar, but for others. Aluminum tanks, pipes, etc., for brewers' and chemical manufacturers' use are flame welded. Nickel is successfully handled under the torch. Cutting tools are being made from low-carbon steel by changing the structure in the oxyacetylene flame. Bases for oil engines, automobile engine cylinders, boiler tubes, pipe, ornamental iron work, are either in the commercial stage of manufacture by flame welding, or are well through the successful experimental stage. The application seems to be as wide as the necessity of joining together or severing two pieces of metal.

In construction work flame welding is being used by plumbers and pipe fitters who are putting in entire piping installations without threaded joints. An instance of this is the five English miles of piping in the Palace of Justice in Cologne, put in in 1910. This is iron pipe put together with oxyacetylene-flame welded points. Not a single screwed joint was used.

In general, flame welding is stated to cost but 40 to 50 per cent. of riveting on the same piece. The shop consuming the greatest amount of gas per day for such welding is a government shop in St. Petersburg, working on army and navy equipment.

The interest in the process is further shown by the facts that for six years a journal has been published in Germany exclusively devoted to autogenous welding, an 800 page hand book has sold to some 5,000 copies, and a

text book for industrial schools is just entering its second edition.—*American Machinist*.

NEW BOOK

Text-Book on Highway Engineering. By Arthur H. Blanchard, C. E., A. M., and Henry B. Drowne, C. E., XIII + 762 pages, 6x9 in., 234 figures and 4 charts. John Wiley and Sons, Inc., New York. \$4.50 net.

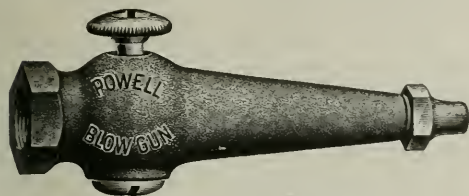
The arrangement of this book, by a professor and an instructor in highway engineering in Columbia University, is based largely upon lectures which have been prepared by the authors for their various classes, undergraduate and graduate, and upon their practice as highway engineers in the United States, Canada and Europe. The book is very complete in character and all parties engaged, either as engineers or contractors on this class of work, will read it with interest and profit. The 27 chapters of the book cover the subject very completely and contractors especially will be able to gain a good knowledge of the various kinds of roads which are now being constructed and the plants and equipment employed. The book appears quite opportunely in connection with the present widespread good-roads movement.

A GIRL'S PNEUMATIC STONE CARVING

A monumental yard's claim to distinction may be frequently based upon some exclusive cutting which it may give its customers and which because of its inherent quality, builds business more rapidly, perhaps, than business in this particular line may be accommodated. Such has been the story of the Troy yard at Utica, N. Y. The pneumatic lettering there is done by Agatha Troy, the daughter of the yard's proprietor, and there is simply no use denying that the young woman's lettering draws business. Miss Troy handles the pneumatic chisels with a touch which no man is ever apt to acquire and produces the fine lines with a delicacy that has made a reputation of her father's yard more than local.

Those Ohio monumental men who are finishing their work with "the air" instead of the chisel, find that it not only effects economy but produces a cleaner and better developed effect. Round letters bloom out in good shape and have a more finished effect than when cut entirely with the chisel. The

finishing of letters by air does not seem to be in very general use, but the plan has been worked sufficiently to demonstrate that it is a good one.—*Granite, Marble and Bronze.*



THE POWELL AIR GUN

The device here shown is not new and the name of it is hardly a correct one. It does not go off with the suddenness of a gun but it does its work quite as effectively. Little real work is done in the world without more or less blowing, and the blower should be at hand. The air compressor is now employed in all industries and the portable air jet is one of its most necessary accessories. Press your thumb on the bottom and it blows hard or gently and as long as you wish. It is made to all the standard pipe sizes, from $\frac{1}{8}$ in. to 1 in. and nozzles are furnished according to the work to be done. The William Powell Company, Cincinnati.



BENT NOSE TIP.



HAT MFRS. TIP.



BUTTON HEAD TIP.



HOSE NIPPLE.

NOTES

Cement gun coating as a protection for metal immersed in sea water has been tested by the Isthmian Canal Commission at Panama. Plates have been coated with $\frac{1}{2}$, 1 in. and $1\frac{1}{2}$ in. of concrete, and after eighteen months' immersion the metal has been found to be free from corrosion.

From Brussels the report comes that the Societe de l'Air Liquide and the Societe Metallurgique d'Ougree Marihay have formed a combination, the object of which is to develop the use of liquid air in connection with blast

furnace operation. The new company is to be known as La Societe d'Etudes et d'Entreprises Metallurgique.

The grade of the Butte copper ores, as stated in one of our exchanges, varies with the price of copper, which seems like putting the cart before the horse. In 1911 the ore mined carried about $3\frac{3}{4}\%$ copper, while in 1912, with the price of copper higher, the ore averaged about 3% copper.

Six thousand rock drills are now in use in the Province of the Transvaal. Of this number, 5,983 were employed on the Rand at the time the statistics were taken, the remainder being in use in other mining districts of the Transvaal. According to government statistics recently published, the actual number of rock drills in commission on the Witwatersrand was 9,018.

Celluloid, as is well known, is almost as inflammable as gun cotton. Chemists have been striving to discover a way to make it less easily ignited, and it is said that they have at last succeeded. Dr. Clement Botrelle has used ether for forming the union of camphor and nitro-cellulose which results in celluloid. The ether evaporates and leaves all the cellulose fibres coated with silica, and non-inflammable.

"Men handling dynamite cartridges with bare hands," says Philip F. Stephens, "often experience severe headaches. Nitro-glycerin is absorbed through the skin and taken into the blood and, being a powerful stimulant, it produces the above malady. This may be avoided by wearing leather gloves doing the work. As the gloves become saturated with nitro-glycerin they should be replaced by new. The gases from the explosion when inhaled also cause headaches."

Two Terry turbine-driven forced draft blower sets, which are probably the largest in point of horsepower in the world, are about to be installed at the Rhode Island Company's power plant at Providence, R. I. Each unit consists of a 600 h. p. Terry Type C-HS turbine, driving through a set of Faulk reduction gears, an American Blower Com-

pany's No. 11 double-inlet Sirocco blower. Each unit has a capacity of 250,000 cubic feet per minute and supplies draft to mechanical stokers. The turbines run at a speed of 3,370 revolutions per minute, the blowers at 460 revolutions.

To reduce operating expenses the United States Mint at Philadelphia will use gas as fuel instead of oil. It will require 30,000,000 ft. of gas a year to melt the bullion from which the coins will be made. Heretofore nearly 240,000 gallons of oil have been consumed annually.

In one or two mines of the Central Rand a considerable saving in "lashing" boys is being effected by imparting a swing to shaking shutes through employment of a hammer drill. The machine is operated at a slow stroke and each stroke of the piston gives the hanging trough a sharp swing, thereby causing the rock to gravitate down to boxholes. We witnessed one such mechanically operated shute at work in a large stope in a deep level mine during the week, and we were informed that a saving of six boys was being effected through substitution of mechanical means for hand labor. In these times of labor shortage the idea, it would seem, might be profitably extended along the Reef.

The following rule is said to have been given recently by the service manager of one of the tire companies: "Inflate the front tire to a pressure in pounds equal to 17 or 18 times their cross-section in inches, and the rear tires to 20 times their cross-section; thus 34 by 4 in. tires should have a pressure of about 70 lb. on the front wheels, and 80 lb. on the rear." It is to be hoped that the tires turned out are better than the rule, which seems almost absurd. The results given above are apparently obtained by using the diameter of the tube as the multiplier instead of the cross-section, and to make the pressure directly proportional to the diameter would give the smaller tubes less than their proper share.

A monster blast in the Boundary District of British Columbia broke down 200,000 tons of ore September 1. The blast was made at the British Columbia Copper Co.'s Mother

Lode mine, at Greenwood. For several months previous, in addition to the ordinary work at the mine, the task of drilling 4,830 holes, averaging in depth between 14 and 15 ft., had been going on under the direction of the company's general superintendent, F. S. Norcross, Jr. This system of breaking ore was begun in 1911, but for dimensions this latest blast exceeded all others that have taken place in the history of the mine. Electricity was used to fire the charges, which were connected by 16 miles of wire, and consisted of 24½ tons of 40% dynamite.

At the automobile testing plant of the Worcester Polytechnic Institute, Worcester, Mass., a speed record of 3,310 revolutions per minute for an automobile motor was recently established. The conditions under which the tests were made approximated, as closely as possible, actual service conditions on the road. A dynamometer indicated that the 20 horse-power rating of the motor was reached at 1,120 revolutions per minute. At 1,900 revolutions per minute 30 horse-power was developed, and at the maximum speed 3,310 revolutions per minute, 36 horse-power, which was equivalent to a speed of 89 miles per hour, was developed. At about 3,300 revolutions per minute the power curve began to drop.

Danger of spontaneous combustion in coal has been the subject of a recent German experiment. Coal is divided into four classes of danger. The coal is pulverized for the tests, then moistened, passed into a tube containing CO₂, and dried. The coal after drying is then heated in a current of oxygen until it ignites, the temperature as also the time needed to ignition being recorded. The temperature at which the coal ignites, after being an hour in the oxygen, is called the initial temperature, and should be 150 deg. as a minimum. Any coal which shows no increase in temperature after this one hour, or else only a slight increase, is termed in the safe class. The coals in the danger class burned after exactly 60 minutes in this temperature and showed a considerable increase in temperature. The degree of brittleness is also said to be an indication whether the coal is dangerous for transportation or not.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

SEPTEMBER 2.

1,071,692. DESICCATING PROCESS. CHARLES

H. BRIGHAM, Brooklyn, N. Y.

1. The process of obtaining the solid constituents of liquids and semi-liquids in the form of a substantially dry powder, which consists in converting the mass into a fine spray and surrounding the spray with an envelop of forcibly projected air introduced under pressure moving in the same direction with the spray.

1,071,713. REFRIGERATING-MACHINE. WIL-

LIAM F. DAVIS, Portland, Oreg.

2. In a refrigerating machine, the combination of a condensing chamber, cooling means disposed therein, compressing mechanism, means to conduct compressed gas from the compressing

foot pieces adapted to be secured to the respective feet of the operator, air compressors in the form of bellows attached to the respective soles of said foot pieces, valve controlled air intake pipes communicating respectively with said compressors and having their free ends supported above said foot pieces, and an air educt pipe adapted to be connected to a pressure tank and having a valve controlled branch leading from each of said air compressors whereby a constant pressure is created in the pressure tank.

1,071,878. PNEUMATIC PUMPING APPARATUS. ADAM EDWARD CHODZKO, Los Angeles, Cal.

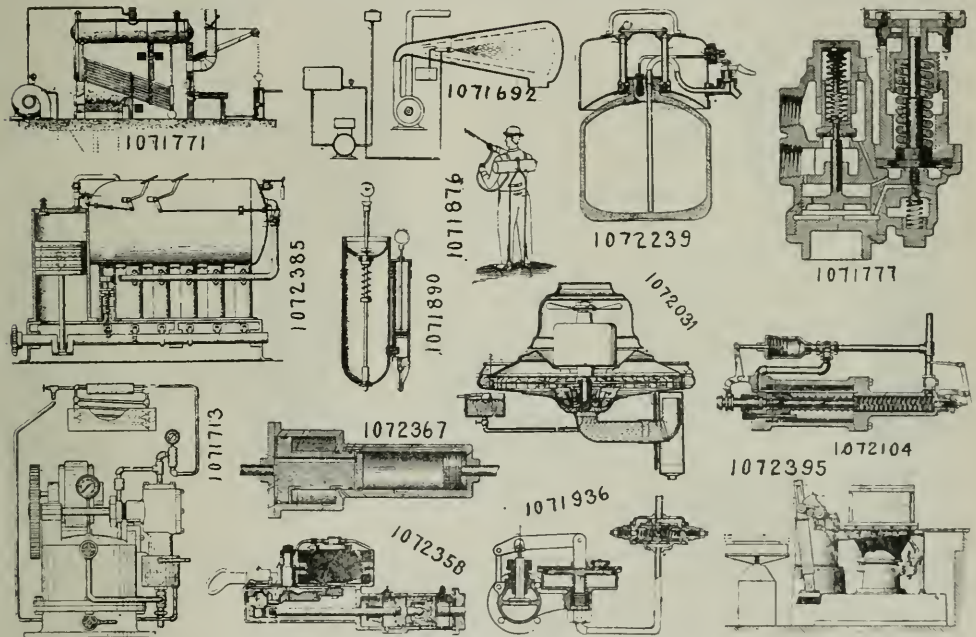
1,071,890. LIQUID-DISPENSER. JOHN DESMOND, Chicago, Ill.

1,071,929. AIR-PUMP. JOSEPH E. LAFORCE, North Grafton, Mass.

1,071,931. VACUUM-MASSAGE. WILLIAM J. LONG, St. Louis, Mo.

1,071,936. AUTOMATIC VACUUM-GOVERNOR. FRANK J. MATCHETTE, Milwaukee, Wis.

1,072,031. ATOMIZER OR HUMIDIFIER. JAMES C. RANKINE, Pawtucket, R. I., and GEORGE H. GOLDSMITH, Biddeford, Me.



PNEUMATIC PATENTS SEPTEMBER 2.

mechanism to the condensing chamber, a pipe to deliver gas to said compressor, an oil pipe connected with the lower part of the condensing chamber, and also connected with the said pipe to deliver oil thereto, an oil filter through which the oil passes before delivery to said first-named pipe, and a strainer located within said compressing mechanism through which the admixed oil and gas pass.

1,071,727. METHOD OF AND APPARATUS FOR DRAWING GLASS. ROBERT L. FRINK, Cleveland, Ohio.

1,071,771. PRESSURE-REGULATING APPARATUS. EMBURY MCLEAN, Brooklyn, N. Y.

1,071,777. FLUID - PRESSURE - REDUCING VALVE. HOWARD M. P. MURPHY, Pittsburgh, Pa.

1,071,876. PUMP FOR SPRAYING DEVICES. LAWRENCE M. CAMPAU, Oconto, Nebr.

1. A pump for spraying devices comprising

1,072,050. TUNNEL - DRIVING MACHINE. GEORGE F. SPEER, Fort Worth, Tex.

1,072,104. FLUID-PRESSURE MOTOR. JAMES E. EBERSOLE, Palmyra, Pa.

1,072,126. PNEUMATIC CARRIER. WILLIAM H. KOEHLER, New York, N. Y.

1,072,133. THERMAL INTERCHANGING PROCESS. JOEL IRVINE LYLE, Plainfield, N. J.

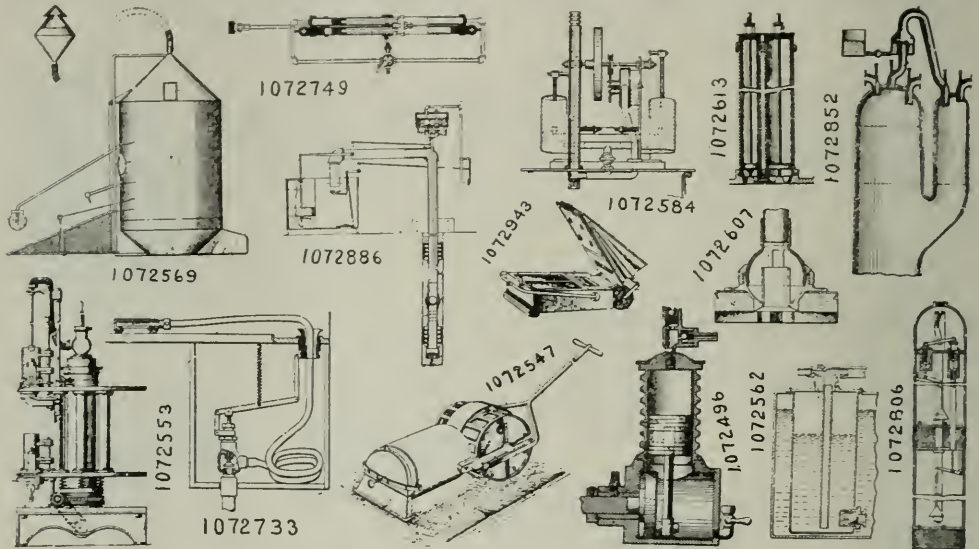
2. The herein described process which comprises the compression of air, then exposing the said compressed air to the influence of a comparatively cool counter air current, then subjecting said compressed air to the action of a previously refrigerated liquid then subjecting the said compressed air thus cooled to the influence of a current of incoming air and conducting it to the place of use.

1,072,239. SIPHON FOR DISPENSING LIQUIDS. ARTHUR KLEINFELDT, Hoboken, N. J.

- 1,072,358. FLUID-PRESSURE-DRIVEN TOOL. ALEXANDER PALMROS, Syracuse, N. Y.
 1,072,359. ROCK-DRILL WITH WATER-FEED. ALEXANDER PALMROS, Syracuse, N. Y.
 1,072,367. DOUBLE-COMPRESSION RECIPROCATING IMPLEMENT. SAMUEL D. SIBLEY, Syracuse, N. Y.
 1,072,385. STARTER FOR HYDROCARBON-ENGINES. JOHN F. KELLY, Chicago, Ill.
 1,072,395. MOLDING - MACHINE. WILFRED LEWIS and JOHN T. RAMSDEN, Philadelphia, Pa.

SEPTEMBER 9.

- 1,072,496. AIR-PRESSURE PUMP. EWALD A. RAVES, Auburn, N. Y.
 1,072,547. VACUUM-CLEANER PUMP. CALVIN C. WILLIAMS, Philadelphia, Pa.
 1,072,553. AUTOMATIC BOTTLE-BLOWING MACHINE. SAMUEL E. WINDER, Waltham, Mass.



PNEUMATIC PATENTS SEPTEMBER 9.

- 1,072,562. HYDROPNEUMATIC VALVE. LOUIS DE L. BERG, Watertown, N. Y.
 1,072,569. SUBMARINE VESSEL. HENRY G. CADY, St. Louis, Mo.
 1,072,576. CONTROLLING DEVICE FOR COMPRESSORS. RUDOLPH CONRADER, Erie, Pa.
 1,072,584. MILKING APPARATUS. LAURITS DINESEN, Velle, Denmark.
 1,072,607. PNEUMATIC CLEANING IMPLEMENT. SEYMOUR L. GUTHORN, New York, N. Y.
 1,072,613. PUMP. CHARLES D. HILL, Rochester, N. Y.
 2. In an air pump, the combination with a base and a pair of cylinders attachable thereto by a rotary movement, said cylinders being provided with ports near their upper ends, of oppositely-acting pistons in said cylinders connected together for simultaneous movement, and a tie piece about the cylinders at the ports, said tie piece having internal grooves communicating with the ports and with each other.
 1,072,749. PRESSURE-MOTOR. JAMES F. McELROY, Albany, N. Y.
 1,072,783. CLEANING APPARATUS. IRA H. SPENCER, West Hartford, Conn.
 1,072,806. PNEUMATIC PUMP. WILLIAM HORACE AUNKST, Milton, Pa.

- 1,072,852. METHOD OF RAISING OR FORCING LIQUIDS. HERBERT ALFRED HUMPHREY, London, England.

2. The method which consists in reciprocating liquid, the initial movement of the outstroke due to a preliminary expansible charge, utilizing energy derived from said outstroke to force air under pressure, mingled with a combustible into the heat zone of the preliminary expansible charge.

- 1,072,886. PNEUMATICALLY - OPERATED PUMP. ERNEST NOBLE WARD and FREDERICK JASPER WARD, Baxter Springs, Kans.
 1,072,943. SUCTION DEVICE. WILLIAM H. HALL, Cicero, Ill.

SEPTEMBER 16.

- 1,073,091. MEANS TO PREVENT CONDENSATION OF WATER ON GLASS WINDOWS. THOMAS CARENCE, Kansas City, Mo.

1. In combination with a window and its frame, an air casing communicating with and located below the window in spaced relation thereto, a valve hingedly connected to the upper end of the air casing and having its free end for engagement with the window, and a vertical strip at each side of the frame, each strip having its outer side hinged to the adjacent side of the frame and having its free inner side extending inwardly toward the center of the window in inclined relation to the latter to deflect the air toward the center of the window.

- 1,073,095-6. AIR - CONDITIONING APPARATUS. STUART W. CRAMER, Charlotte, N. C.
 1,073,139. STARTER FOR EXPLOSIVE-ENGINES. GEORGE HARTWELL KELLEY, Gainesville, Fla.
 1,073,149. SAND-BLAST APPARATUS. GEORGE R. LAWRENCE, Cleveland, Ohio.
 1,073,159. POWDER-SPRAYER. LEE AARON NAUSS and RAY JOHN NAUSS, Greenville, Ohio.
 1,073,175. FLUID-PRESSURE SWITCH. JOHN ALBERT SCHADEL, Pittsburgh, Pa.
 1,073,337. VALVE MECHANISM FOR AIR-COMPRESSORS. WILLIAM S. FAIRHURST, New York, N. Y.
 1,073,338. VALVE. WILLIAM S. FAIRHURST, New York, N. Y.

1. A sheet metal valve comprising an annular portion provided with two inwardly and oppositely projecting arms each leading from one side of the annular portion to a point adjacent to the other side thereof, the heads of said arms having holes for the reception of guide pins.

1,073,354. AUTOMATIC AIR-ESCAPE VALVE. CHRISTOPHER LAUTERBACH, Baltimore, Md.

1,073,445. ASH-EJECTOR. JOHN H. SNELLING, Newark, N. J.

5. In an apparatus of the character set forth, a hopper of tapering form for the reception of material to be discharged, said hopper having a passage in its wall and an upwardly inclined jet-hole leading from said passage to the interior of said hopper, means for supplying fluid under pressure to said passage at the narrowest part of said hopper and jet-hole, and means for leading away the material to be discharged.

1,073,451. GRAIN-SEPARATING MACHINE. MORRIS WEAVER, Jonestown borough, Pa.

1,073,454. AIR-GUN. ADOLPH WISSLER, St. Louis, Mo.

1,073,867. PNEUMATIC - DESPATCH - TUBE APPARATUS. ALBERT W. PEARSALL, Lowell, Mass.

1,073,872. VACUUM DRYING APPARATUS. OLIVER S. SLEEPER, Buffalo, N. Y.

1,073,876. CLOSED - HOPPER SAND - BLAST. GEORGE F. STEEDMAN, St. Louis, Mo.

1,074,051. AIR-PUMP. FRITZ K. HOHENSTIEN and CHARLES G. MEYERS, Richmond, Ind.

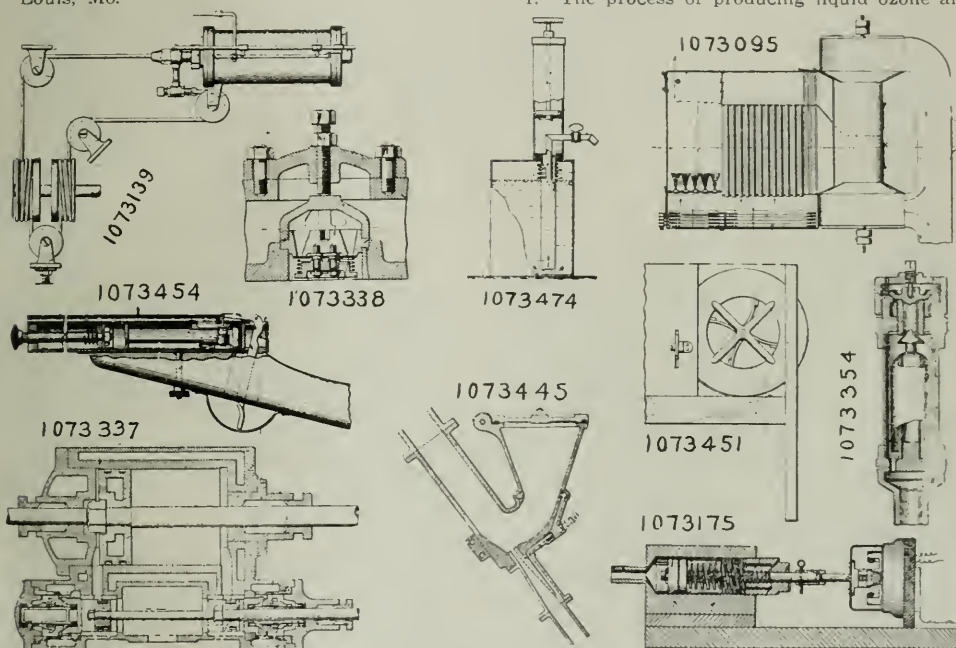
1,074,094. APPARATUS FOR LIQUEFYING GASEOUS MIXTURES. HERMANN BLAU, Augsburg, Germany.

SEPTEMBER 30.

1,074,098. AIR CHARGING AND PRIMING DEVICE FOR SUCTION-PUMPS. JOHN ASTROM, Fort Wayne, Ind.

1,074,106. PROCESS OF PRODUCING OZONE AND SEPARATING GASES. HORACE DUMARS, Glen Ridge, N. J.

1. The process of producing liquid ozone and



PNEUMATIC PATENTS SEPTEMBER 16.

1,073,474. PNEUMATIC - OPERATED PUMP FOR LIQUIDS. HERBERT WILLIAM COPLESTONE, Bunbury, Western Australia, Australia.

1,073,475. AIR-CONDITIONING APPARATUS. STUART W. CRAMER, Charlotte, N. C.

SEPTEMBER 23.

1,073,609. ARRANGEMENT FOR VENTILATING AND FOR MOISTENING THE ATMOSPHERE OF PREMISES. JEAN FREDERIC PAUL KESTNER and HENRI JEAN EMILE NEU, Lille, France.

1,073,630. LIQUID - RAISING APPARATUS. JAMES F. REDDY, Rochester, N. Y.

1,073,646. ORCHARD-SPRAYING MACHINE. FRED C. THOMPSON, Granger, Wash.

1,073,801. UNLOADER AND STARTER FOR COMPRESSORS AND PUMPS. ERNST FRIEDRICH, Barmen, Germany.

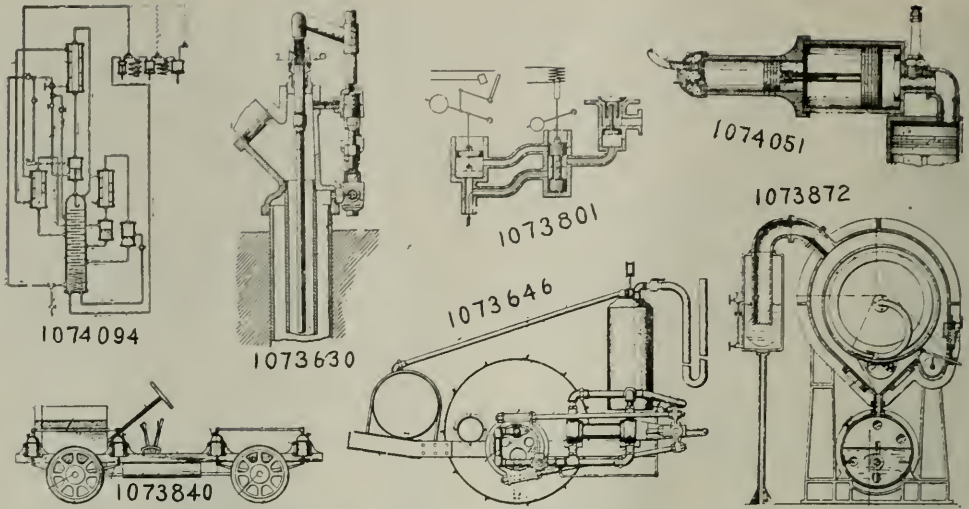
1,073,840. PNEUMATIC SPRING FOR VEHICLES. TOMAS LUIS DE BEJAR and BERNARDO LANZAGORTA, Habana, Cuba.

separating air gases which comprises reducing air to a temperature somewhat below the liquefying point for ozone, but above the liquefying point for oxygen and nitrogen, and at such temperature subjecting the oxygen of the air to the action of ozonizing means, and separately collecting the liquid ozone and the remaining gases of the air.

1,074,116. ROTARY PERCUSSIVE TOOL. CHARLES H. HAESELER, Philadelphia, Pa.

1,074,224. DOUBLE-PRESSURE PUMP-GOVERNOR. WALTER V. TURNER, Edgewood, Pa.

1. The combination with a pump governor normally operating at a predetermined maximum degree of pump pressure for cutting the pump out of action and at a predetermined minimum degree of pump pressure for cutting the pump into action, of a valve mechanism operating at higher maximum and minimum pump pressures for controlling the supply of operating fluid to said governor to thereby cause the governor to operate at predetermined maximum and minimum degrees of pump pressure higher than the normal.



PNEUMATIC PATENTS SEPTEMBER 23.

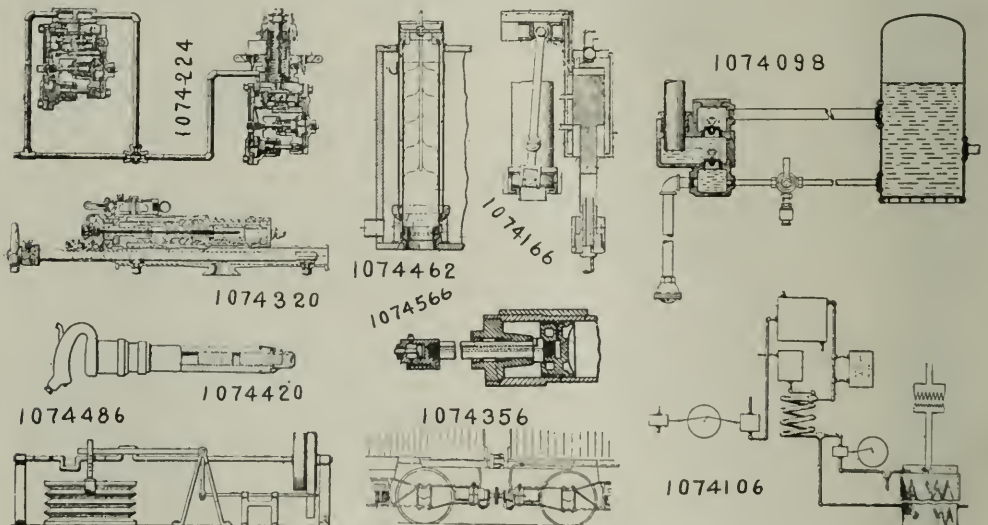
- 1,074,320. AUTOMATIC FEED FOR PERCUS-
SIVE DRILLS. CHARLES C. HANSEN, Easton,
Pa.
1,074,356. AUTOMATIC AIR-COUPPLING. FRED-
ERICK N. FISHER, Columbus, Kans.
1,074,420. SPRING-CLIP FOR PNEUMATIC
HAMMERS. JOSEPH F. EISCHEID, Plattsmouth,
Nebr.
1,074,462. OZONIZER. FRANCIS H. RICHARDS,
Hartford, Conn.

1. In an ozonizing apparatus the combination with a pair of concentric tubes having between them an annular space, of a self-adjusting upper ring for the outer tube and having a tube-bearing shelf on its inner side; a lower self-adjusting ring for the inner tube and having a tube-bearing shelf on its outer side; a ring-supporting frame member having an annular lower bearing-

surface for the inner ring and ring-supporting bearing-surface for the upper ring, and having side-outlet air-passage space located at a height between the two rings.

- 1,074,486. AIR-REGULATOR FOR ORGANS.
PAUL OTTO BOESKE, Manton, R. I.
1,074,566. RUN-OUT GEAR OF HEAVY ORD-
NANCE. ARTHUR TREVOR DAWSON, Westmin-
ster, London, and JAMES HORNE, Barrow-in-
Furness, England.

1. In run out gear for ordnance the combina-
tion with the air cylinder, its floating piston
and the packing rings of said piston, said piston
being subjected to air pressure on one side and
to liquid pressure on the other side, of means for
forcing liquid into a cavity between said packing
rings and for subjecting it to a pressure which is
greater than that in the air cylinder.



PNEUMATIC PATENTS SEPTEMBER 30.

COMPRESSED AIR

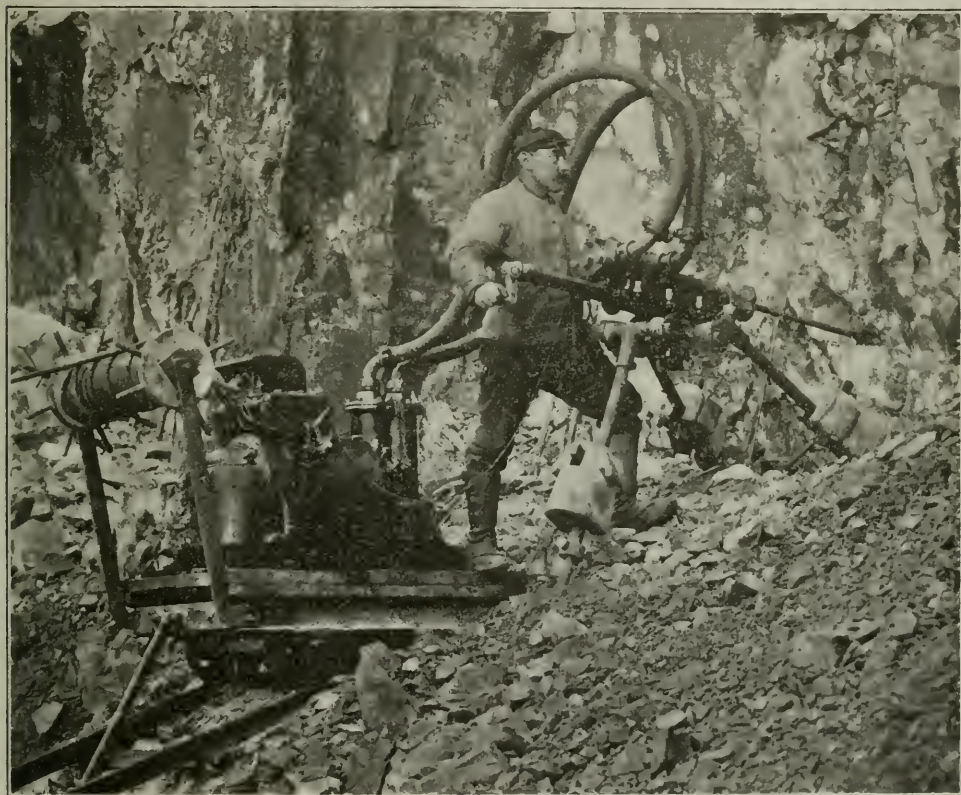
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ELECTRIC AIR DRILL IN GERMAN PORPHYRY QUARRY.

TYPICAL ELECTRIC-AIR DRILL EMPLOY- MENTS

The half-tone on this page must be left to tell its own story, as we have little definite information at hand concerning it. We are simply given a lifelike view of an electric-air drill and its operator at work in a porphyry quarry belonging to the German government.

A drill of this type is easily movable from hole to hole or to different locations, the temporary track here shown not being generally used. The reel for the wire saves the necessity even of disconnecting it if the moves are frequent and not over great distances.

This is an entirely complete, self-contained and independent unit, requiring no connection

with anything outside itself except the wires conveying the current. It often happens, especially in the regions where quarries are located, that there is a water power available within practicable distance, and until the advent of the electric-air drill a typical installation would comprise a generator near the waterfall, wires to a power house, a motor there driving an air compressor, with a man to look after it, and then air pipes to and distributed through the quarry and hose to the individual drill. The apparatus here shown embodies or rather displaces all the installation, does the work certainly not less effectively and at, say, one-third of the power cost.

TYPICAL RAILROAD BUILDING

An unusually interesting piece of railroad work has been the construction of the Elkhorn extension of the Carolina, Clinchfield and Ohio Railroad, crossing the Sandy Ridge of the Cumberland mountains. The line is 35 miles long, mostly in Virginia, with one terminal at Elkhorn in Kentucky, and the other at Dante in Virginia due south of the former. With the exception of a little more than a mile at the Dante end, the grade over the entire line is descending toward the north.

Practically the entire line is on side hill as the location follows the streams very closely, cutting through tunnels wherever necessary to save distance. In the 35 miles there are 20 tunnels, with a total length of 3.9 miles, more than 11 per cent. of the entire length.

Although the work was very heavy the most difficult problem was the getting in of material and supplies. The country is extremely rough and in most cases there were no roads suitable for heavy hauling, and it was necessary for the contractors to spend considerable money in improving and maintaining the roads. Steam shovels, compressors and boilers were in some cases hauled from 20 to 30 miles, where little of the way was nearly level.

Most of the small tunnels were driven by putting through a top heading for the full length and then taking out a bench to the full tunnel section. Fig. 1 shows typical tunnel sections, both on solid rock and where lining was required. Caney Creek tunnel, 400 ft. long was taken out entirely by hand. The material was a soft slate with a coal seam which proved

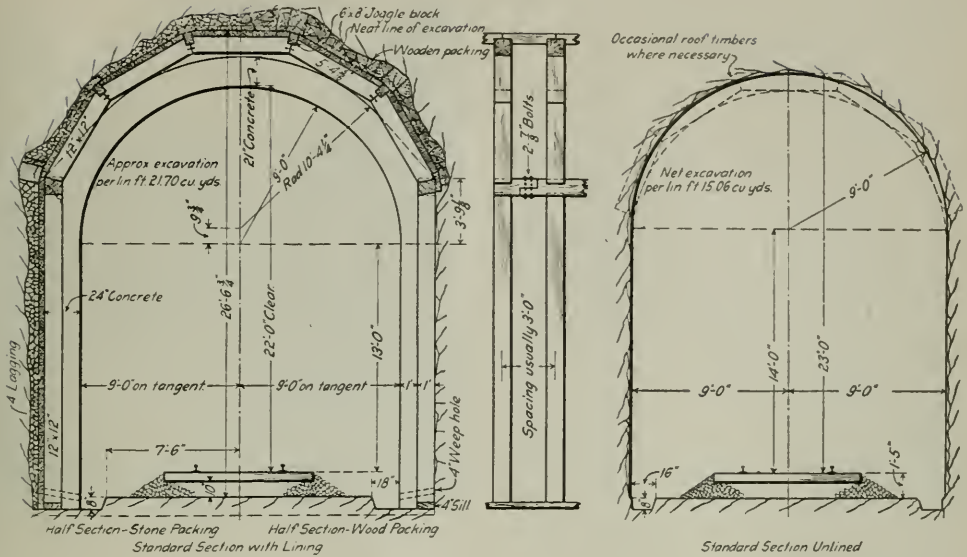
to be exceptionally good material for ratchet drills. Steam drills were used in two tunnels, and air in all the others.

As an example of the tunnel plants that were installed at points where it was very difficult to get in machinery, the air compressor used by one of the contractors in driving three tunnels about 17 miles from Dante was an Ingersoll-Rand AA2 with cylinders 20¼ in. and 13¼ in. by 18 in. The heaviest pieces handled weighed from three to 3 1/3 tons, which had to be hauled for the entire distance over the very rough mountain roads.

SANDY RIDGE TUNNEL.

The tunnel under Sandy Ridge is 7,804 ft. long and is about 900 ft. under the summit of the ridge. About 250 ft. at the north end of this tunnel was in badly broken material and requiring lining, but it is not expected that the remainder of the length will require it. The tunnel is being driven from both portals, taking out the full section as the work progresses. The headings are kept only about 12 ft. ahead of the first bench to provide room for the drills to put in a round of heading holes while the muck from the preceding charge is being removed. Four 3¾ in. air drills are used in the heading to place about 22 holes in each round. The drills are mounted on columns in the heading and on tripods on the benches, which are taken down on two levels, the upper one having 6 vertical holes in each charge, and lower bench 4. The charges are made with 60 per cent. dynamite. In each round, the lower bench is shot first and this is followed by the upper bench and then the heading. The material is of hard slate and sandstone lying in heavy ledges, some of which are as much as 10 ft. thick. All material is handled by Marion 41 shovels, operated by air and equipped with 1½ yd. buckets. Four-yard dump cars are handled in trains of five by electric locomotives.

The electric and air plants which have been installed in duplicate at the two ends of this tunnel are very completely equipped and represent a total outlay of between \$60,000 and \$75,000. The electric power is secured from a power house of the Clinchfield Coal Corporation on Dumps creek, about eight miles from the tunnel, where current is generated for the company's mines. This power is transmitted at 6,600 volts a.c. on a three-wire trans-



mission line, and is transformed at the tunnel plants to 2,300 volts a.c. by three G.E. type H, 60-cycle, 125-k.v.a. transformers. This 2,300-volt current is used in a motor-generator set to produce 250-volt d.c. current for the lighting circuit and for operating the electric locomotives hauling the muck trains. Separate lighting and power circuits are run into the tunnel and along the approaches. Electric lights are provided in the roof of the tunnel on the center line, one foot below the roof grade, for the use of the foremen in alignment.

Compressed air for drills and shovels is furnished by Ingersoll-Rand Imperial type compressors, belt driven from 300 h.p. motors. These compressors have cylinders 25 and 15 in. diam. by 20 in. stroke. The air is carried at 110 lb. in an 8 in. line down into the approaches and tunnel headings. Ingersoll-Rand E-44 drills are used and, in addition to the eight drills in each heading, air is supplied to the shovel, two Cameron pumps, two well drills and a Leyner drill sharpener. The latter is operated by two men and is able to sharpen 200 drills in the day shift. A full stock of drills and repair parts is carried to eliminate delays. A No. 7 Cameron pump is in service at the south portal and a 14 in. fan line has been installed for ventilating at



each end. About 100 ft. of the complete tunnel section is finished per week.

SPECTACULAR ENGINEERING.

At a point known as "the Towers" the line cuts through a tunnel 890 ft. long and in a high ridge between the sides of a loop in the river about $1\frac{1}{2}$ miles long. The work from "The Towers" to the State Line tunnel is the most spectacular on the whole extension. Russell Fork at this point flows through Pine ridge in an irregular canyon known locally as "The Breaks," the mountains rising on both sides from 800 to 1,000 ft. above the river. At a number of points the walls of the canyon are nearly perpendicular. It was first planned to have two tunnels at "The Towers," the north one of the two cutting through a narrow wall of rock extending practically out to the river. As the work progressed it was found that the nature of this rock would not allow the building of a satisfactory tunnel, so that it was decided to bench off this rock wall and lay the line in open cut along the face of the bluff.

The contractor handling "The Towers" tunnel had one of the most difficult problems on the entire work in getting in equipment and material to his camp. The only access by road to this position of the mountains is by a very long, crooked trail from Elkhorn City, which winds over the mountain from two to three miles east of Russell Fork. This trail strikes a little stream known as Camp Branch about $\frac{3}{4}$ mile from Russell Fork and follows down this branch toward the larger stream, which flows into Russell Fork at a point almost opposite "The Towers" tunnel. On account of the inaccessibility of the west side of the stream from the north it was necessary for the contractor to locate his camp and compressor plant along this branch on the opposite side of the river. He hauled all material from Elkhorn over the winding mountain road for 10 miles, taking apart all the heavy machinery so as to reduce the weight of individual pieces. By using six spans of mules, and in many cases helping them with blocks and tackle, he was able to get in two boilers, the heaviest of which weighed 14 tons. He also installed an Ingersoll-Rand compressor with a capacity of 790 cu. ft. per min., and laid about $1\frac{1}{2}$ miles of 4 in. pipe from the compressor to the tunnel headings. All of this pipe, the drills and all powder used on the work had to be carried



BENCHING OFF ROCK AT THE TOWERS.

on men's backs from the camp across the river and up the steep bank to the tunnel portal. In order to reach the north portal which was worked simultaneously with the south, these supplies were carried over the top of the ridge and let down by ropes along the face of the bluff.

The State Line tunnel was much easier to reach, although it also presented many difficulties. It was driven from both portals and a side drift which was run in from the face of the canyon to allow headings to be pushed in both directions from the center. One of the contractors handling grading between "The Towers" and the state line brought in a 20-ton steam shovel over the road from Elkhorn City on the east side of Russell Fork, but owing to high water, had to wait more than six weeks before he could get an opportunity to transfer the shovel across the stream.

The preceding is an abstract of a portion only of an elaborate and excellent article in *Railway Age Gazette*, Nov. 7, 1913.

The general contract for building the entire line, including clearing, masonry, grading and tunnels, was let to the Rinehart & Dennis Company, Charlottesville, Va. Hollis Rinehart, general manager of this company, has general charge of the work and E. J. Perkins is the superintendent on the ground. The Rinehart & Dennis Company is driving the Sandy Ridge tunnel and seven shorter tunnels

with a total length of about 8,000 ft., and handling about 12 miles of grading. The remainder of the work was sublet to 15 companies. The railway company will lay the track with company forces. The entire work of location and construction is handled for the company by Ward Crosby, chief engineer. The line is divided into six residencies in charge of the following resident engineers, the order being from Elkhorn south; J. W. Moore, C. D. Stanper, J. H. Charlton, C. P. Norris, L. R. Wilcox and W. C. Hatton.

JOPLIN DRILLING CONTEST

The fourth annual drill contest was held in the Joplin district, Missouri, on Sunday, Oct. 19, at which time all previous records were broken and a new record of $36\frac{3}{8}$ ins. in Carthage limestone was established. This record was made by Smith and Long, who have led all contestants for three successive years, thus obtaining permanent possession of the gold-plated trophy hammer offered to the team making the high record for three successive years. Two other teams made records very close to that of the winner. Bailey Anderson and Q. L. Seagraves of the Comet mine at Webb City drilled $35\frac{5}{16}$ ins. Tom Harrison and Frank Smith of the Newton & Harrison Mining Co. of Galena, Kan., drilled $34\frac{7}{8}$ ins. The time of drilling was 15 minutes. Moving pictures of the contest were taken, and they will be the first pictures of this great sport of the mining industry ever displayed.

LOS ANGELES AQUEDUCT CELEBRATION

In the first week of November the city of Los Angeles, California, celebrated with imposing ceremonies the inauguration of its great aqueduct. This monumental engineering work, details of which have had mention in our pages from time to time, was to Los Angeles what the Catskill aqueduct was to New York. It represents eight years of work and \$24,500,000 in expenditure. It will bring pure mountain water from the snow-capped Sierras, a distance of 260 miles across deserts and through mountains. It will deliver 258,000,000 gallons of water every twenty-four hours to reservoirs nearly 1,000 feet above the city. This is enough to supply a city of 2,000,000 inhabitants, and Los Angeles is not that—yet.

LOCATING MANUFACTURING PLANTS*

BY W. L. SAUNDERS.

In considering the choice of location for a manufacturing plant the question of labor, materials, power and transportation are all of the greatest importance; and it is sometimes equally necessary to consider markets. The character of the industry should determine which of these elements is paramount.

For a paper mill or a carbide factory first consideration should be given to the question of power, because this item ranges from 50 to 80 per cent. of the total cost of the product. This is why paper mills are located where water power is available, and as wood pulp is their raw material this can usually be supplied at the least expense along a river course, where we have the power and the raw material factors controlling. Paper being made by machinery the labor cost in comparison with these other factors is not a serious item when considering location.

Furthermore, there is a certain amount of steadiness about the work of a paper mill. It is not subject to the violent fluctuations that occur in general manufacture. Such fluctuations affect the question of the volume of labor employed, and make it important to consider the labor market of the neighborhood.

Cement factories locate where the clay and other raw materials are plentiful; in fact one seldom sees a cement works located anywhere except over a clay deposit. It is of the greatest importance, however, in the cement industry to obtain cheap power, because cement is now made by machinery, and this is one of the reasons for the cement industry in New Jersey and Pennsylvania, where coal is cheap and plants have flourished and increased to so large an extent.

In textile manufacturing, and in the machinery line, labor and transportation are controlling factors. The relative importance, however, of the labor to other items which go into the cost sheet varies with each class of manufacture. There is also the broad problem of business policy to be considered, but in a general way in textile and mechanical things labor controls the situation.

*Abstract of a portion of an address delivered before the Graduate School of Business Administration, Harvard University, Sept. 26, 1913.

The class of labor is a sub-division of great importance. It is a fatal mistake to locate a factory where skilled labor is employed, such, for instance, as for the making of typewriters, in a locality noted only for its large supply of common labor. New England is a choice field for typewriter factories, and is preferable to Birmingham, Alabama, although in the latter place labor is more plentiful.

In textile work it has been shown by statistics that the cheap, common labor of the South does not compare favorably in cost of output with the more expensive skilled labor of New England. If this were not so we might reasonably expect that all cotton factories would be located in the South, where the raw material grows.

There are few things manufactured in America concerning which it may invariably be said that cheap labor means low cost. The contrary is usually true; for where skilled labor is employed the unit cost of product is less than in places where cheap unskilled labor is used to do the same kind of work. This in itself is a very broad subject and I shall not discuss it in detail, except to call your attention to the fact that in that part of the world where labor is cheapest; namely China, Japan and India, manufacturing does not prosper. The Japanese, with all their enterprise and skill, have been unable to compete with England, Germany or America in the manufacture of steel products, although the actual cost of labor in the steel works of Japan is one-eighth of that in the United States.

In considering the item of transportation, it naturally follows that waterways adjacent to the works afford economical transportation advantages. The importance of this item is increased as the weight of the product increases. That is, the heavier the material manufactured the more important becomes the consideration of cheap transportation. Pig iron can be delivered cheaper by water than by any other means, yet pig iron is not usually made at or near rivers and harbors, because consideration must be given to the raw material, and to the markets for the distribution of the product. If the consumption of pig iron is mainly or wholly in the interior, it might pay to locate the furnace somewhere near the area of consumption, provided raw material is available, and even where this is not at hand it may pay to transport the raw

material by freight, paying for a long haul, so long as the point of delivery of the pig is in the neighborhood.

An illustration of the controlling influence of transportation may be given in marble, granite and other stone works, where the material is heavy. It may cost more to freight a block of stone than to quarry it, and where quarries are located near tide-water it is a great advantage to the business from an economical standpoint.

In the case of the stone industry, however, and in fact in any industry producing a heavy product, a tide-water advantage in location of the factory may be entirely counteracted, unless there is a market for the product close to tide-water. The great marble quarries of Carrara are situated so near tide-water that this material is loaded upon ships and transferred to the markets of the world, competing in cost of delivery, in the United States for instance, with material quarried inland, which must be transported by rail. The wealth of England has been largely built up through her coal mines, which are located so close to tide-water that this product has been, and still is, shipped to all parts of the world in competition with home industries that are not so favorably situated. It has been said that the reason why America does not supply the world with coal is because her mines are so far from the seaboard.

LOCATING IN CITY OR COUNTRY?

Having once determined the general geographical location for an industrial plant, the question then arises as to whether it is better to establish the business in or near large centers of population or remote from such centers in a rural district. On this point experts differ very materially, and before giving the pros and cons it is best to eliminate certain industries which belong to a class all by themselves: an industry, for instance, which employs so high a grade of labor that the workers may be called artists in their line; such, for instance, as engravers, silverware workers, and many other special lines which require a limited labor force, a force that is pretty steadily employed in artistic work.

In this line the country seems best suited because the trained workmen are likely to establish themselves with homes and to be free from the tempting environments of a large

city. They will be less apt to strike because of home influence, and for the further reason that there are not likely to be other sources of artistic employment in the vicinity. Strikes usually occur in the larger centers of population, and the strikers seek employment either in the same line of business or in other lines in the neighborhood, thus making it unnecessary for them to change their homes.

There are also some who advocate a country shop in cases where a large volume of untrained common labor is employed, the argument being that an untrained country boy makes a better workman than a lad from the city. It is true that the best common labor is found in the country. This is because the life and training of young men in the country is more conducive to work and good habits. The habit of work becomes established and the grade of character is usually higher.

This, however, hardly offsets certain disadvantages. In the first place, the volume of common laborers in an isolated place must necessarily be small. There is only a limited supply to draw from, and when this has been exhausted it becomes necessary to import workmen. This is frequently done by bringing Italians, Slavs and other foreign laborers to the plant, and here we reach a condition where the labor becomes most uncertain, because these foreigners only establish themselves for the purpose of making money, and not to live and move and have their being. An industry, therefore, which is likely to call for large supplies of common labor, and which may be more or less uncertain in its demand, is very likely to be handicapped if located in the country.

Among the errors often committed in locating works in the country is that of locating *near* a large city, without being actually on its border or in its suburbs. In the vicinity of New York, for instance, there are a large number of communities where men commute, going back and forth to the city each day. Where works are located within commuting distances from New York it is difficult to get workmen to move from the city permanently to the country, because they are city men. They like the city life, have been accustomed to it and are unhappy if transferred. Furthermore, wages in the city are usually higher than in the country. Now, in order to recruit a working force, the supply in this suburban

city is drawn upon, and it is found difficult to get young men, because young men prefer to take positions in the large city, going back and forth each day. They will do this even at lower compensation. The city acts like a magnet to absorb young people who might otherwise render valuable service at the works.

A works management that does not give due consideration to the value of young men is an incompetent management. It is from the youthful energy of the beginner that most productive work is obtained, and if young men cannot be had, old men are employed at a disadvantage to the cost sheet. The importance of this can hardly be overestimated, because it is a well known fact that older men seek the country, while younger men seek the cities.

I should say, therefore, that in artistic specialties and where the works are of moderate size a country site is best, but in practically all other lines the points of advantage seem to be with cities. This does not mean location directly in a large city, but on its border, somewhere within carfare distance and directly in it, provided, of course, that the problem does not become one of cost of real estate or means of transportation of materials and product.

Few, if any, manufacturing lines are absolutely stable in their output, that is, manufacturing is an uncertain business, subject to fluctuations produced by general conditions that are beyond control. Mr. Carnegie has said that the steel business is a feast or a famine, and this applies to a smaller extent perhaps to almost every line of manufacture. There are busy times and there are dull times. During busy times we want plenty of men, and are increasing our force, during dull times we are laying them off, and here is where the advantage of a city is most marked. Having a large supply of labor, whether skilled or unskilled, we are able to draw upon this supply in times of activity, and in dull times we may lay men off without compunctions of conscience, because they seek work elsewhere in the same community, and many of them come back if they are wanted when times are good. To be confronted with a declining market in a country location means that we must lay off men, some of them perhaps may have been with the works for a long time. These men may have their homes there and as they must live they migrate to some other town and are lost

permanently. The alternative is for them to remain around the place in poverty and distress.

In large centers of population there are usually other lines of manufacture where the boys and girls of the workmen may be employed, such, for instance, as silk mills, stocking factories, organ factories, etc. This is an important consideration in locating works. A mechanic, for instance, usually gives his boys and girls a public school education. After that they must seek employment. If they cannot get it in the neighborhood they go away from home, to some large city usually, and this is likely to result in drawing the parents away, perhaps at the very time when they are most needed, and perhaps permanently.

Such exceptions as Gary, Indiana, cannot be used as an argument against the proposition. The Steel Corporation is so big, and its works at Gary have been established on so large a scale, that they can afford to go out in the woods, establish works and build up a city. This has been done at Gary, which can hardly now be called a country town. Besides, the governing conditions there were transportation facilities on the Great Lakes. The iron ore is brought down from the Mesaba Range by water, is converted into steel and is transported by water to the large markets.

Another exception, for instance, is that of Pullman, Illinois; and here let me say that if it is the purpose of those locating works to speculate in real estate a country site is likely to be most attractive. Pullman, however, is an example of the folly of attempting to run a manufacturing plant properly and to at the same time speculate in real estate. The two do not go together, and while there may be a temporary period of activity and profit, there is very likely to be a day of reckoning, because the one most important factor which makes for permanent success in handling men is to establish among them a feeling of absolute confidence. If they feel that they are being used to promote a land enterprise, or if their homes either belong to the company or are taxed by the company, or if they are expected to purchase them through the company, a feeling is engendered which does not make for efficiency and success. The great strike at Pullman has, I think, settled this question.

Those who claim advantages for the country site use with some force the argument that in cities strikes are more liable to occur than in the country. This is, of course, true. Unions are usually stronger in cities than in the country, but unions and strikes are passing shadows. They have no permanent place anywhere and are likely to flourish in one district or another as circumstances may change the situation. It must also be taken into consideration that when a strike does occur in the country, there is little chance to replace the strikers, there is no labor market available, while in the city there are always opportunities to continue the works, even on a reduced scale during a strike period.

In these general thoughts I do not refer to "cities" as very large communities particularly, but as places where some 25,000 or more people live, where there are amusements for the workmen, where railway and other transportation facilities are available, and where land is plentiful.

PLANNING FOR GROWTH

There is no greater mistake made in locating works than to begin on a small area that is hemmed in and which does not afford opportunities for expansion. No one can tell what the future may bring forth in a manufacturing business in America. I have seen works expand against great obstacles, such as hills and rivers in the immediate neighborhood, or against expensive land or buildings which must be acquired in order to provide facilities for taking care of the product. I have known this to become so acute that it was found best to abandon the site entirely and locate where there was more room.

It is a good rule to follow, to build with care, providing only for the immediate needs of the business, but let that building be located on property which affords ample room for growth. Small buildings and plenty of land are the best beginning. There is a further economic reason for this in that wherever works are located property increases in value in the vicinity. This has a far reaching effect in many lines of manufacture, and the concern that makes this possible should have land enough for its own future needs to warrant the investment of its capital.



PLAINFIELD WATERWORKS POWER HOUSE AND GRAVEL WELL.

A HIGH-DUTY AIR-LIFT CITY WATERWORKS PLANT

The air lift installation of the Plainfield-Union Water Company, at Plainfield, N. J., has many interesting features besides its large pumping capacity. Its location is in a valley which shows superincumbent strata of water-bearing sand and gravel of varying depths down to a limit of about 100 ft., below which is rock also yielding water, but which differs somewhat from the former in chemical characteristics and otherwise, indicating a flow from a different source.

The gravel water, which has a normal level of about 34 ft. below the surface, is the product of the immediately surrounding watershed. A series of wells were sunk in this gravel down to the rock and had been pumped for years by two vertical duplex triple-expansion condensing steam pumps of 5 and 6 million gallons per day capacity, maintaining by means of a stand pipe a pressure of about 65 lb.

As it became necessary to increase the water supply of the city plans were made to install an air-lift plant. It was desired to use the supply from the underlying rock and to so combine the two systems that the suction installation in the gravel could be used

independently of the air system in the rock, or that both could be used in conjunction.

THE ROCK WELLS.

About fourteen wells were drilled to a depth of between 350 and 400 ft. distributed over an extensive area so that they were separated from each other by a distance of at least 20 yd. They were 10 in. in diameter, having a casing driven down to and a short distance into the rock, thus effectively sealing off the gravel water. These wells were considered sufficient to furnish an adequate supply for all emergencies, but it was determined to tap the gravel waters and to pump them also by air.

To install an air and discharge pipe in one of the existing suction wells in the gravel was a simple and innocent proposition until the question of submergence arose. For a lift of about 70 ft., as here required, there should be a submergence of 60 to 75 per cent., which would demand for the piping an additional depth of, say, 130 ft.

Accordingly a 10 in. well was drilled and cased to the rock about 90 ft. deep; the size of the tools was then reduced to 8 in. and the well was extended to a total depth of 200 ft. below the surface. The well as bored then stood 10 in. down to the rock and 8 in. to the bottom. A pipe a trifle smaller than the

well and plugged at its lower end, with a 20 ft. length of screen or perforated pipe of larger diameter, connected to its upper end by a reducing coupling, was let down into the well so that the coupling rested on the shoulder of the rock where the bore was reduced to 8 in., thus suspending the pipe in the rock, the screen having a pipe fitted to it which extended to the surface.

The outlet pipe which cased the well in the first place was then withdrawn entirely with the result that the gravel water would flow through the screen and down into the pipe in the rock where it is prevented from passing out by the plug in the bottom. The air pipe passing down inside the plugged pipe nearly to the bottom completed the air lift so far as the well was concerned.

TESTING THE WELLS.

A temporary plant was installed for the testing of each well as to its yield and character and experimentally to determine the best conditions of submergence, column and velocity, to secure the best results. For this work a small Ingersoll-Rand steam driven air compressor was installed and pipes were laid to three wells. The offers of three air-lift concerns to equip one well each in their own manner and run a competitive test were then accepted, the company demanding that they should conform to standard form in making their tests and compiling their results. The figure proposed to be obtained was the percentage of power theoretically used in raising from the well the actual number of gallons, the actual number of feet, to the amount of power consumed by the compressor, or, in oth-

er words, the percentage of water horsepower to air horsepower.

In Table I are shown the results of the tests on well 1, which was assigned to the Harris Air Pump Company of Indianapolis, and the methods used by all in keeping the results and comparing the records.

The final figure, 30.9 per cent. efficiency, was the best obtained from any of the competitors, and was considered very good, in view of the facts that the installation was of a temporary and makeshift character, and that the compressor was not especially economical in steam consumption. From this representative well we know:

First—The number of gallons the well yields at maximum efficiency.

Second—Amount of air required.

Third—Drop, which, plus the static head gives the distance required to lift the water.

From these are derived the pressures necessary to start and run, also the horsepower and efficiency. What is to be sought is the relative point between air, water and lift where the efficiency is the greatest.

Table II illustrates this and shows the result of a test taken from one well to determine that point. With the compressor running at different speeds, the water production was measured and the pressures noted, and we were able to show the rise and fall in the relative efficiencies as the speed, viz.: air production, was changed.

It is to be noted that the greatest amount of water is produced by the greatest amount of air, and also the other extreme; but still there is a point when a gallon is produced by

TABLE I. TEST WITH HARRIS SYSTEM DEEP WELL
No. 1, 300 Ft. Deep

Casing	93 ft. x 10 in.
Air pipe	158 ft. x 2 in.
Discharge	163 ft. x 6 1/4 in.
Static head	37 ft.
Pumping level	60 ft.
Drop	23 ft.
Elevation	5 ft.
Total lift	65 ft.
Submergence	98 1/2 ft.
Percentage of submergence	60.2
Pressure start	55 lb
Pressure running	47 1/2 "
Gallons per minute	499
Water hp.	8.19
R.p.m.	92
Receiver pressure	51
Feet per minute	197
Air hp.	27.18
Air per gal.	0.394 ft.
Over-all efficiency	30.9
Shut in press.	42 1/2
Temperature of water	54 Deg.
Duration of run	2 hours.

TABLE II. RELATION BETWEEN AIR, WATER AND PRESSURE

R.p.m.	120	100	80	75	65
Free air per minute.....	255	213	170	160	138 cu. ft.
Gallons water per minute...380		337	312	280	205
Drop of well.....	21 ft.		18.5 ft.	16 ft.	14 ft.
Air per gallon.....	672 ft.	633 ft.	545 ft.	572 ft.	673 ft.
Pressure	42	43	44	44	45
Efficiency	19	20.5	23.4	22.5	18.8%

the smallest fraction of a cubic foot of air, which point corresponds with the point of greatest power efficiency, where the relation between air horsepower and water horsepower is the greatest, and, as in this plant, so in any other plant can likewise be determined an input of air which will give the most economical results.

THE NEW PLANT.

Preliminary tests having proved conclusively that there was abundant water to be had, a large addition to the power house was built and, without interfering with the working of the old plant, there were installed two Ingersoll-Rand cross-compound condensing air compressors, with Corliss steam gear, and of the latest and most refined type, OC. 3. The main receiver was connected to air mains of 4 in. and 6 in. diameter, and to these trunk lines, the wells were joined by 2-in. lines with provisions for cutting out any well or series of wells as desired.

The wells themselves were equipped by the Harris Air Pump Co. with its patented 20th Century foot piece and umbrella top discharge, and the discharge of the wells was carried by gravity to a 500,000-gal. reservoir, from which the steam pumps took their supply for distribution.

After this plant had been in operation about one year, it was decided to make a test and determine how the wells had been affected, and also what was the general working condition of the system. Under normal conditions of water production and steam consumption, 8 wells working simultaneously were giving an ample supply of water, and the compressor, governed by the pressure regulator, was making about 77 r.p.m. As it was obviously impractical to measure either the supply of air or the discharge of water from each well individually, and thereby obtain the efficient working of each well, a much simpler and more ingenious method was employed in determining the theoretical percentage of submergence for the well in question and then proceeding to adjust the air throttle at the

well, at the same time noting the change of pressure which would denote the change in submergence.

When the submergence was so adjusted that it comprised with the total discharge pipe the right percentage of submergence, we may assume that the well was working at its most economical point. The result of this adjustment is shown in Table III for each well, and in each case an average was taken to indicate the general performance of the system.



WELL WITH UMBRELLA DEFLECTOR.

The length of discharge pipe in each well has been taken as 100 per cent., and, knowing the lift to be somewhat between 80 and 90 ft., we find from tables that the percentage of submergence is between 55 and 60 per cent., consequently we admit just that amount of air to the well which will draw down the water to a point that gives the shut-in pressure that determines the correct submergence.

This simple adjustment in a typical case resulted in a great saving of power, for, on returning to the power house, it was found that the compressor had automatically slowed down to 67 r.p.m., the pressure being constantly maintained by the regulator, and that the wells were delivering the same amount of water. We can accordingly say that during the time elapsed since the system was first operated

TABLE III. REPORT OF TEST MADE AT PLAINFIELD, N. J.,
MARCH 25th, 1912

No. of wells	3	4	5	6	8	9	10	11
Depth	350'	400'	350'	300'	304'	350'	350'	350'
Length of discharge (100%)	204	204	203	204	210	217	205	213
Starting pressure (lbs.)	66	60	60	65	65	65	65	65
Running pressure (lbs.)	59	55	55	57	56	60	54	55
Shut in pressure (lbs.)	53	51	50	54	51	54	48	50
Submergence, per cent.	60	57.5	56.5	61	56	57	53.5	54
Submergence (ft.)	122	117	115	124	117	124	110	115
Lift (ft.)	82	87	88	80	93	93	95	98
Free air constant	.400	.432	.440	.387	.462	.447	.485	.489
Average submergence								118 ft.
Average percentage of submerg.								57%
Average lift								89.5 ft.
Average constant								.443

the wells had changed in some respects, and in other cases the throttles were admitting more air than economy demanded. This is one instance where as much as 10 per cent. of power may have been saved.

With these wells in proper adjustment, it was desired to determine the amount of water lifted, likewise the power required to produce the air for this work. As the water was flowing into the reservoir from a number of discharge pipes this could not be accomplished there, and therefore it must be measured as it passed through the steam pumps on its way to the stand-pipe with due allowance for fluctuations in the reservoir. The power required to compress the air was determined from indicator cards taken from the steam end of the compressor.

The results of this test are shown in Ta-

ble IV, together with an incidental run with the pump shut down to check the slippage of the pump, and also check the actual pumpage.

From these figures we draw our general conclusions as to the economy and efficiency of the system. 3666 gal. p.m. lifted 89.5 ft. =

$$\frac{3666 \times 89.5 \times 8.33}{33,000} = 82.85$$

$$\begin{array}{r} \text{I.hp. in steam cylinder, 211.} \\ \text{w.hp.} \quad 82.85 \\ \hline = 39. + \text{ per cent.} \\ \text{i.hp.} \quad 211 \end{array}$$

In this case we may safely say that losses due to mechanical friction, and adiabatic compression have been reduced to a minimum by providing a compressor of most refined and

TABLE IV. TEST

Time, a.m.	10:05	10:20	10:35	10:50	11:05
Compressor, r.p.m.	67	67	67	67	65
Working pressure	69	69	69	69	68
Water lift reservoir	30% in.	31% in.	30 in.	33% in.	32% in.
Rate of pump encounter	7743	8201	8654	9087	9561
Steam pressure	115	109	114	114	104
Average revolution of compressor per minute					66.6
Average working pressure					68.8
Revolution of pump in one hour					1818
Size of duplex pump cylinders					20 1/2 x 24-in. stroke
Gallons per revolution					137.2
Gallons pumped in one hour					249,429.6
Gallons pumped per minute (displacement)					4157.1
Estimate slippage, 10%					415
Actual gallons pumped per minute					3742
Size of reservoir					250 x 22 ft.
Gallons in reservoir per inch					2437.5
Loss in reservoir in one hour					1% in.
Loss in reservoir in gallons					5586.5
Loss in reservoir per minute					93.1
Actual gallons pumped per minute					3649

In order to check the slippage of pump, a test was run on the reservoir with the wells alone, stopping the pump.

Time of test	15 min.
Water lift in reservoir increased	16 in.
Gallons pumped per minute	3666

Size of compressor used { Steam cylinder, 34 x 30
 { Air cylinder, 32 1/4 x 21 1/4
 { Strokes of all cylinders, 27 in.

Cu. ft. displacement in compressor per rev.	23.77
Average revolution per minute	66.6
Cu. ft. free air per minute displacement	1593
3666 gallons per minute lifted 89.5 ft. equals 82.85 w.hp.	
w.hp. divided by i.hp. equals 39.26% efficiency.	

improved type, while the friction of the air in pipes, and slippage of water have been likewise affected by the design and selection of the well equipment. The losses, therefore, are those that we cannot expect to lessen substantially, due to the difference in temperature of the air at point of delivery and of application with the cold water.

Just what the fuel consumption of the air plant alone was we were not able to determine, but taken in conjunction with the steam pumps, which were forcing the same water against a head of 150 ft., the entire plant was handling on an average day approximately 5,700,000 gal. and consuming 12 tons of coal.

Given \$2.60 as a fair price per ton, this would be about \$0.005 per thousand gallons pumped. The result of this installation may well be considered a conclusive and demonstrable denial to contentions and assertions that the air-lift as a system is extravagant and uneconomical; for, given its proper sphere of operation and due care and provision in selecting and installing, results may be realized that permanently recommend and establish its use.

The above is much condensed from a paper in *Practical Engineering* by Mr. C. F. Ivins who superintended the installation of the plant described.

HEROIC TEST OF ELEVATOR AIR CUSHIONS

The passenger elevators in the Woolworth building, New York, are provided with efficient safety devices in the form of air cushions to prevent the shock of a sudden drop. Those who descend in these elevators are reminded of the presence and operation of these air cushions by the noise of the rush of air when nearing the bottom. The escape of the air is gradually diminished from the beginning of the cushioning effect until its completion. An elevator in the building was recently loaded with 7,500 pounds of pig iron, equal to the weight of 50 adults, and given a free drop from the 47th floor. The cushioning is said to have begun at the 11th floor; the carriage landed at the bottom as gently as could be desired and without rebound.

Four hundred locomotive repair shops throughout the United States, Canada and Mexico are now equipped for Thermit welding.

DISPLACEMENT VERSUS DELIVERY OF AIR COMPRESSORS

BY C. M. SPALDING.

The phrase "air compressor capacity" which is frequently used in correspondence and conversation is ambiguous and often misleading.

Air compressor capacity may mean piston displacement in cubic feet of free air per minute when working against any given gauge pressure; or it may mean the quantity of air delivered, expressed in cubic feet at atmospheric pressure; or it may even be used by some to mean the quantity to be delivered, expressed in cubic feet of air at the pressure at which it is intended to be stored or used. The word capacity should be avoided in this connection as it results in confused ideas, and some precise expression of the quantity of air desired should be used instead.

Air compressors are commonly rated by their piston displacement, or, when fully stated, by the piston displacement in cubic feet of free air per minute when operating against some stated gauge pressure. This is a value easily determined as it only involves the diameter of cylinders, the stroke, and the revolutions per minute of the crank shaft, when operating against the stated gauge pressure. It is used by all builders of reciprocating air compressors and is very convenient in determining, approximately, whether a given air compressor is suitable for a given service; but it is necessary to understand its relation to the delivery of the compressor in order to make such use of it.

The discussion which follows is limited to single acting compressors because electrically driven air compressors for railway service are ordinarily of this type. Let us consider the equation:

$$\frac{\text{Area of piston in sq. inches} \times \text{Number of pistons} \times \text{Stroke in inches} \times \text{R.P.M.}}{1728}$$

= Piston displacement in cu. ft. of free air.

It should be understood that this result, while stated in terms of cubic feet of free air, is not a measure of a quantity of air at all, but only the expression of a volume, which may be filled with air at any pressure. As an example, if a compressor was used as a

vacuum pump it would have its displacement volume filled with air at approximately the pressure of the chamber which is being exhausted instead of with air at atmospheric pressure and temperature (free air). And, further, this piston displacement volume does not imply the delivery of the entire quantity of air corresponding to the piston displacement, but holds some relation to it which is explained in the course of this article. Finally, it does not include the gauge pressure at which the air is delivered; this pressure only being referred to because compressors when working against different pressures run at different speeds. In the case of a two-stage compressor, such as is used for the higher pressures required on the heavier locomotives, the low pressure cylinders only are used in the calculation.

The delivery, in cubic feet per minute, is a percentage of the piston displacement; this percentage is known as the volumetric efficiency of the compressor. It varies quite widely, the fundamental causes of this variation being the size of the compressor and its terminal gauge pressure at which the air is delivered. These causes will produce a considerable variation in the delivery of a series of compressors of different sizes, even though all are designed along the same lines with equal care; or in the same compressor when delivering air at various gauge pressures. Besides these there are other causes of variation in the volumetric efficiency which affect the results obtained, but which may be controlled and reduced to a minimum; among these are the volume of the clearance spaces, the type of valves, piston rings, etc.; much may be gained in efficiency by giving intelligent thought to these points in designing a compressor. Also the seating of valves, the fit of the piston rings, etc., are points where the workmanship becomes a very important item in producing the desired result.

This percentage of volumetric efficiency may be as high as 88 per cent. in a large two-stage compressor operating at 135 lb. gauge pressure or as low as 57 per cent. with the smallest single stage air compressors used for air brake service on street railway cars.

The gain in volumetric efficiency by two-stage operation over single-stage operation is due to the much lower terminal pressures in the low pressure cylinders of the two-stage ma-

chine, as compared with the terminal pressures in the single-stage machine. These pressures affect both the quantity of air left in the compressor clearance spaces and the amount of leakage past the piston rings and valves. The same relation between volumetric efficiency and terminal pressure may be observed when considering single-stage machines only. For example, if we take the case quoted above of the very smallest type of compressors for air brake service and operate it at 60 lb. instead of 90 lb. its volumetric efficiency becomes 66 per cent. instead of 57 per cent. It should also be understood that in the smaller compressors the clearance volume becomes necessarily a larger percentage of the total volume.

It is not proposed in this article to enter into a detailed statement of volumetric efficiency of various compressors, but to make some general statements showing why the delivery is less than the displacement. We will assume a compressor of 70 per cent. volumetric efficiency and state the approximate amount of the various losses which combine to account for the missing 30 per cent.

The intake air is never quite up to the atmospheric pressure from which it is drawn; that is, if we consider the atmospheric pressure as 14.7 lb. absolute pressure, then the air in the cylinder at the end of the intake stroke may be assumed to be 0.7 lb. less, or 14 lb. absolute, and this incoming air will be heated by contact with the walls of the cylinder head and cylinder to perhaps 12 deg. C. above the atmospheric temperature. Thus our quantity of air which might be contained in the cylinder and its clearance spaces is reduced to 91.5 per cent. of its value in free air before we begin to compress it.

The compressor must have a certain amount of mechanical clearance to prevent the piston striking the cylinder head, and to this volume must be added the volume of the ports which are provided for the passage of air from and to the valves. The combined volume of these items is the clearance referred to in the preceding paragraph when considered with reference to the air delivery. It is kept as small as possible by careful designing but must be consistent with a suitable area of air passages, and may be taken as from 2.5 to 3.5 per cent. of the total volume of the piston displacement plus clearance. In the comparison here made it is assumed to be 3 per cent. The speed

of the compressor is assumed to be 200 r.p.m.; that is, the compression stroke of each piston in a two-cylinder compressor occurs in approximately 0.15 sec. This time being so short, there is very little interchange of heat between the compressed air and the walls of the cylinder, which means that the air becomes very hot and the compression is nearly adiabatic. In addition to this it is necessary to carry our compression considerably above reservoir pressure for the purpose of lifting the valve, and it remains slightly above reservoir pressure after the valve is opened to induce the flow of the necessary quantity of air through the valve ports and the pipe to the reservoir, during this brief interval of approximately 0.04 sec. in which the valve is open. Our clearance volume is now filled with air at a pressure slightly above that in the reservoir. This air is left behind in the cylinder, when the piston begins its return stroke and the valve closes. Under the conditions stated, our clearance volume has become 14 per cent. of our total volume so that if there were no other losses we should have a delivery of 77.5 per cent., but we have still to account for the air which leaked past the piston rings and that which has leaked back past the inlet valve, these leakages should be, and are, kept as low as possible; but they exist in all compressors and must be taken into account. These piston and valve losses taken together represent the 7½ per cent. not already accounted for.

When the intake air separator, which is provided to remove dirt from the incoming air, is improperly installed so that dirt gets under the valves, the valve losses become very much greater and the delivery correspondingly less. For example, in one instance the writer when overhauling a compressor which had been in service several years increased its delivery 50 per cent. by simply taking it apart, washing out the valves and valve chambers and re-assembling.

Two or three other points may be profitably noted, which, although they are not a part of the statement of volumetric efficiency, should be kept in mind when considering the suitability of a given air compressor for a given service.

When compressed air is used in moving a piston in a cylinder it must be considered in terms of absolute pressure; for example, when

an air brake piston is moved through an assumed stroke, dependent upon the mounting of the brake rigging, wear of shoes, etc., with a gauge pressure of say 50 lb.; the quantity of free air used would be expressed by the absolute pressure in atmospheres multiplied by the volume of the cylinder including its clear-

ance in cubic feet: $\frac{50+14.7}{14.7} \times \text{vol. in cu. ft.} =$

quantity in cu. ft. free air. There is a very small temperature correction which may be disregarded.

When compressed air is to be measured as delivered to a tank or reservoir of known volume the procedure is as follows:

The tank ordinarily contains air at atmospheric pressure and temperature at the beginning of the test. Let us assume that we are going to fill it to 90 lb. gauge pressure; then we have at the end of our test a tank full of

air at $\frac{90+14.7}{14.7} = 7.122$ atmospheres; that is,

we have that many times its volume in terms of free air, except as affected by temperature, but it is usually at somewhat higher temperature than the surrounding air, and in this case the temperature correction should be included if close results are desired. For example, if the surrounding atmospheric temperature is 25 deg. C. or 298 deg. C. absolute and the temperature of the air in the tank is 40 deg. C. or 313 deg. C. absolute, then the air actually in the tank when it had cooled to the surrounding temperature would be reduced in absolute

pressure to $\frac{298}{313} = 0.954$ of its absolute pres-

sure at 40 deg. C. Its value for the cubic feet of free air, at atmospheric pressure and temperature, actually delivered after deducting the air in the tank at the beginning of the test would be

$[(7.122 \times 0.954) - 1] \times \text{tank volume in cu. ft.} =$
cu. ft. free air delivered.

It may be of interest to compare the relative values affecting the volumetric efficiency found for larger compressors of the double acting type, such as are used in stationary service, as given by Mr. E. A. Rix when discussing the same general subject in the Mining and Scientific Press. It will be noted that his figures include leakage through the piston rod

stuffing box, which feature does not exist in single acting compressors; and valve slippage or the shifting of the valve on its seat, which is so small an element in railway air compressor valves that it has been considered negligible. He takes as typical for the purpose of his illustration 70 per cent. volumetric efficiency when operating a single-stage compressor at 100-lb. receiver pressure. If the compressor were operating at 90 lb. pressure its volumetric efficiency would be 73 or 74 per cent. On the other hand he is considering a line of compressors of larger displacement, so that on the whole the conditions are sufficiently near to furnish us with an interesting comparison. His item of temperature losses includes losses due to the intake fall in pressure.

Railway air brake compressor single acting against 90 lb. gauge pressure.

Stationary air compressor double acting against 100 lb. gauge pressure.

Intake loss due to fall in pressure 4.8 per cent.

Intake loss due to increase in temperature, 3.7 per cent.

Clearance loss, 14 per cent.

Piston loss, 7.5 per cent.

Valve loss, 7.5 per cent.

Total, 37.5 per cent.

Temperature loss, 7 per cent.

Clearance loss, 16 per cent.

Piston and rod loss, 3 per cent.

Valve leak and slippage, 4 per cent.

Total, 30 per cent.

General Electric Review.

MOVING PICTURES OF FLYING BULLETS

Moving pictures have unlimited possibilities apparently for the study of rapidly moving objects. An apparatus capable of making pictures at the rate of 100,000 a second has been made. With it seventy-two pictures of a revolver bullet were taken while moving ten inches. Pictures of a bullet passing through a stick of wood showed a curious condition. The bullet passed completely through the thin stick and was well on its way beyond before the wood gave any sign of distress. Then some tiny splinters started out, following the bullet; the stick began to split, and after the

bullet had proceeded some distance the stick suddenly fell to pieces. No camera shutters are fast enough to take pictures at anything like this speed, so no shutter was used. Instead, a series of electric sparks was flashed, the sparks following one another at the rate of 100,000 a second, each spark making a picture. The film was mounted on a wheel about three feet in circumference, and the wheel was revolved at the rate of 9,000 revolutions a minute. When all was ready, the bullet was shot, the spark flashed and the wheel revolved, the actual exposure being limited to a fraction of a second so as not to pile up pictures one over the other.—*Machinery.*

UNDER WATER ROCK DRILLING ON THE TENNESSEE RIVER

"Professional Memoirs" of the Corps of Engineers of the United States Army and Engineer Department at large comprises valuable and authoritative accounts of engineering operations of widely varying character and location. Mr. J. E. Hall, assistant engineer, recently contributed to the above publication an interesting account, abstracted below, of work on the Tuscumbia bar which extends for a couple of miles in the Tennessee River 200 miles below Chattanooga. The bar is composed of a series of blue flint-limestone ledges overlaid with a thin coating of gravel, and the improvement project contemplated the excavation of a channel 150 ft. wide and 5 ft. deep, connecting the deep waters above and below the obstruction.

Extensive drilling being necessary in rock on top of which the depth of water varied from a few inches up to 5 ft., it was thought advisable to mount tripod drills on floats having sufficient buoyancy to carry men, drills and material to operate them and still be able to float in shallow water.

The floats used for the first season's drilling (1911) were composed of nine small boats, the dimensions of each being: Depth, 1 ft.; width, 5 ft.; and length, 25 ft. These were arranged in three rows, with three boats in each row, and a space of 2 ft. was left between the lines of boats through which to operate the drills. During the first season they were turned longitudinally across the current and the float was held in place with spuds 6 in.

square. When the boats were so arranged the floats were 19 x 75 ft. At each placing of the drill unit two lines of holes were drilled, extending half-way across the channel, and twelve holes were put down in each line. These lines being 7 ft. apart made the average spacing of the holes $6\frac{1}{4} \times 7$ ft., and the holes were put down to a depth of 7 ft. below low water.

DRILLING PROGRESS.

The drilling was carried on on this basis until Dec. 15, 1911, when it was terminated by high water and bad weather. During this season's work about 2500 lin. ft. of channel, beginning at the upper end of the work, were drilled and blasted. Where the detonation was perfect the rock was usually broken up, but often in such large pieces as to be very difficult to handle, and it was sometimes necessary to break them again with mud-capped shots before they could be handled.

Table 1 shows the 1911 season's work, giving the unit cost of drilling for each month, also the stage of the river, depth of water over the rock drilled and depth of the drilling in the rock.

TABLE 1—RESULTS AND COST OF WORK DURING 1911

Month	Lin. ft.	Average depth of holes, ft.	Gage, ft.	Depth of water over rock, ft.	Cost	Unit cost
August	3,520	4 to 5	.4 to 2	3 to 5	\$1,336.60	\$0.38
September ..	6,338	3 to 5	.3 to 1.5	3 to 4	2,871.20	.40
October	6,921	3 to 5	1 to 5	3 to 7	3,450.00	.50
November ...	10,373	4 to 5	1 to 3	2 to 6	4,634.39	.43
December ...	1,679	4 to 6	2 to 12	4 to 7	1,007.40	.66
Total	28,831				\$13,299.59	

Average unit cost for season 1911, \$0.46. Number of linear feet of channel drilled, 2,500.

Extensive repairs being necessary to the floats before entering on another season's work, it was decided to rearrange the boats composing them, turning them lengthwise with the current and leaving the opening between the boats 1 ft. wide. The floats used in the season of 1912 were composed of thirteen boats, 1 x 5 x 25 ft. long, put together in this way, making the spacing of the lines 6 ft. apart instead of 7, as in the previous year. The dimensions of this float were 25 x 77 ft.

At each placing of the drill unit or float twelve lines of holes were drilled, each line having six holes. As the length of the boat was 25 ft., the spacing of the holes was made 4 x 6 ft. and the holes were put down to a

depth of 9 ft. below low water. In addition to the advantage of narrowing up the spacing, the placing of the boats lengthwise with the current was an advantage, in that they were less affected by the action of the current and drilling could be carried on at a higher stage of water.

TABLE 2—RESULTS AND COST OF WORK DURING 1912

Month	Lin. ft.	Average depth of holes, ft.	Gage, ft.	Depth of water over rock, ft.	Cost	Unit cost
June.....	3,720	7 to 8	3 to 5	3 to 5	\$1,523.19	\$0.41
July.....	3,256	7 to 8	3 to 6	3 to 6	1,465.00	.45
Aug.....	15,120	7 to 8	2 to 3	2 to 4	5,727.28	.38
Sept.....	15,752	6 to 7	1 to 3	1 to 5	6,301.85	.40
Oct.....	20,250	5 to 7	1 to 2	2 to 4	9,317.50	.46
Nov.....	20,042	5 to 7	.5 to 1.5	3 to 4	10,462.59	.52
Dec.....	7,568	5 to 7	1 to 6	3 to 7	6,659.84	.88
Total.....	85,708				\$41,457.55	

Average unit cost for season 1912, \$0.483. Number of linear feet of channel drilled, 2,500.

In comparing this season's work with that of 1911 it will be noted that the unit cost of the drilling is $2 \frac{3}{10}$ cents in excess of the 1911 cost. This may be due to considerable advantage in weather and river conditions in 1911, and also to the fact that the drills were all new in 1911, while in 1912, especially near the close of the season's work, a number of them were badly worn and would not deliver a normal stroke. After September the cost is also augmented by the shortening of the days, making it necessary to work a longer number of hours at night. While the plants are very well lighted, quite a falling off is noted in their progress when comparing the result of an hour's work at night with an hour's work in the day. Early in October a number of the best drill men left the work to go back to their old stations at the furnace, and it was necessary to fill their places with new men.

ARRANGEMENT OF WORK.

The following method was universally followed during both season's work: The drill floats were placed in proper position for work by accurately lining them with ranges, marking the center of each half of the channel, and by cross-ranges which marked the lower extremity of the drilling and blasting already done. A float thus lined is in position for drilling one-half the width of the channel for a distance of 25 ft., or the length of the boats. At each setting twelve lines of holes were drilled, with six holes in each line. Each float carried eight drills, all of which are operated by steam.

To prevent the holes from filling with gravel and silt the drilling was done through tubing or pipe 3 to 4 in. in diameter. From three to five drill bits were used in putting down each hole, the first bit being $2\frac{1}{2}$ in. in diameter and the last $1\frac{3}{4}$ in. When the hole was down to a proper length, a pipe that would exactly fit the top section of the hole was put in, the bit taken out and the hole loaded, the charge consisting of 80 per cent. gelatin dynamite and varying from six to ten sticks, according to the depth in the rock. The stick, having the primer was placed about one-third of the way down from the top, having two or three sticks on top of it and from four to six under it.³ The charge was firmly packed down in the bottom of the hole with wooden poles which fitted very closely the section of the hole. When the loading was completed the hole was marked by a cane, which was firmly embedded in the charge, leaving the top about 6 in. above the surface of the water, and the primer wire was looped around the top of the cane. When all the holes were loaded the primers were all carefully connected so as to make three circuits, twenty-four holes to each circuit, leaving the end wires of the first and fourth line looped around the top of the cane so that they might be readily found and connected with the lead. The float was then dropped down from over the holes and a set of lead wires attached to each circuit. When these were connected (insulated tape being used for making all these connections) the float and tender were dropped back about 250 ft. below and the charges ignited by using three large batteries.

DRILL SHARPENER.

During the first season the drills were all sharpened by hand, but in 1912 a Leyner drill sharpener, operated with compressed air, was installed. A considerable saving was effected, as one blacksmith and helper were able to sharpen steel for twenty-four drills, while three blacksmiths and helpers were necessary to do this work by hand.

The seeming excessive cost of drilling here is due to the character of the rock, which is the very hardest of flint. It was found a very difficult matter to get steel that would stand this rock. The slightest mistake in tempering would cause the bits to fail at once.

COMPARISON OF WORK.

The season's work for 1912 covered the

heaviest part of the blasting, as it began at the upper end of the extremely shallow water and extended entirely below it. While the number of linear feet of holes drilled in 1912 was about three times the amount drilled in 1911, only about the same channel area was covered, viz., 2500 lin. ft. This was on account of the narrow spacing of the holes, the additional depth drilled and the fact that this season's drilling covered the heaviest part of the work. There is now left above the dam an area undrilled about equivalent to 1200 lin. ft. of channel.

The average day's work for one drill unit operated with a double crew was 432 lin. ft.; average hour's work, 27 lin. ft.; average hour for one drill, $3\frac{3}{10}$ lin. ft.

TABLE 3—COST OF TENDER EQUIPPED FOR WORK

Building hull, cost of labor and subsistence . . .	\$1,346.66
Lumber and iron, nails, spikes, oakum, etc. . . .	1,902.40
Brownell boiler of 90 hp.	900.00
Leyner drill sharpener, No. 2	697.10
Compressor for running same	533.00
Receiver for air storage	64.80
Steam capstan	495.00
Setting up and connecting the above-named machinery	185.40
Building one-story cabin for sheltering machinery, material, and labor	465.00
Total cost of tender	\$6,589.36
Type of float now in use, composed of 13 boats; cost, labor and material	1,140.00
Eight drills, E-24 Ingersoll-Sergeant	1,950.00
Steam hose, drill steel, iron pipe	365.00
Cost of float, equipped for drilling	\$3,455.00
Cost of tender	6,589.36
Cost of one drill unit	\$10,044.36

During the first season's work any boat having sufficient boiler power that could be spared from the plant was used as tender. The floats could be very quickly built, and they were put to work in this way pending the building of a suitable tender. The type of boat built for this purpose is a barge 30 x 80 x 4 ft., provided with three spuds. It is equipped with a 90-hp. boiler, a Leyner drill sharpener, a compressor for operating same, and a steam capstan for handling the barge. The sharpener is driven by air, the compressor in use being one manufactured by the Chicago Pneumatic Tool Company, having a 9-in. cylinder for steam and air, with 11-in. piston stroke, and a piston displacement of 130 cu. ft. of air per minute at 100-lb. pressure.

Three drill units were operated during the season of 1912, and it was found that one drill sharpener could keep steel in shape for the three units, each of which carried eight drills. Only one tender, as described in the

foregoing, has been built for the work here, the other two units being furnished with steam by spare pieces from the plant.

During 1911 28,831 lin. ft. of holes were put down, loosening up about 23,155 cu. yd. of material, costing as follows:

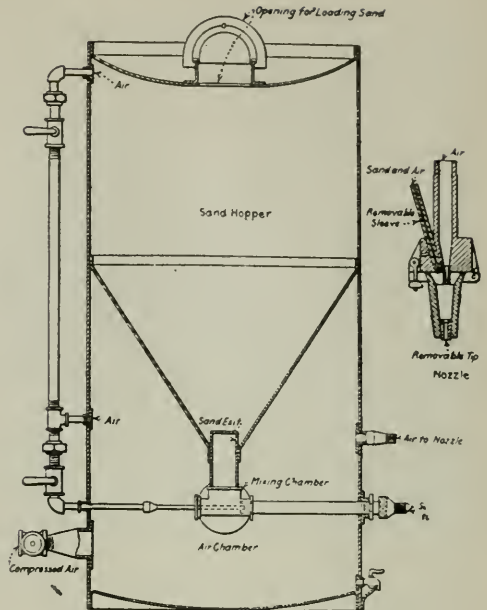
Actual field cost, including material, salaries subsistence, etc.....	\$13,299.59
Deterioration of plant on account of season's work	3,840.00
Overhead charges	664.98
Total cost	\$17,804.57
Cost per linear foot.....	0.617
Cost per cubic yard, loosened.....	0.76

During the season of 1912 85,708 lin. ft. of holes were drilled and blasted, loosening up 76,185 cu. yd. of material estimated in place, costing as follows:

Entire field cost, material, etc.....	\$41,457.75
Estimated deterioration of plant.....	7,500.00
Overhead charges	2,072.88
Total cost	\$51,030.63
Cost per linear foot, drilled and blasted.....	.595
Cost per cubic yard, loosened.....	.677
Total amount of material loosened up in the two seasons, cu. yd.....	99,566
Total amount of dynamite used, 75,450 lb.....	\$12,855.36
Amount of dynamite per cubic yard, $\frac{3}{4}$ lb.....	.127

EVANS HIGH PRESSURE SAND BLAST*

Sand blast machines have been in more or less successful use for many years, the first device of the kind having been patented in or about the year 1870. This was followed by several others, all of which have been utilized chiefly for cleaning stone buildings, soft iron and brass castings. These machines are all of the single hose type; they have been tried in removing old paint and rust from metal structures, and as found by experts in operating at a low pressure it took a long time and did not remove the rust or paint completely, leaving it on in spots. As soon as sand blast machines had been in use for a few years the United States Navy Yard in Brooklyn, in 1897 cleaned, or attempted to do so, the man-of-war Brooklyn. The work was not satisfactory to the Government and I believe has never been tried since then on U. S. Government ships. It has, however, been in use to a certain extent in foundries of the navy yards. It remained for the Evans high-



HIGH PRESSURE SAND BLAST APPARATUS.

pressure sand blast machine to be the first machine which ever successfully cleaned steamships, which was done at the Cramp shipyard in May, 1912.

Bridge engineers became deeply interested in the question of sand blasting structural steel, because the mill scale, which is on all structural steel, must be removed before the first, or shop, coat of paint is applied, otherwise corrosion is bound to take place and the I-beams will become gradually eaten up by rust. This rust operates on steel exactly as a cancer on a human body and undoubtedly many railroad wrecks, which have occurred on bridges even when incased in cement, have been directly from the effect of the corrosion of the steel beams. We have proved beyond the peradventure of a doubt that wherever mill scale is not removed even under paint, when exposed to weather or dampness, and even when incased in cement that a chemical action does take place, and the structure is thereby enormously weakened. While this may not be of great interest to you gentlemen of the foundry trade, still it shows the necessity of using a sand blast on steel or iron whether it be structural material or castings which enter into the general manufacturing business and uses for the general trade.

*From an address by David Sands Ferris of the Carter Metals Cleaning Company, Philadelphia, before the Associated Foundry Foremen of Philadelphia, Oct. 8.

Right here a further word in regard to the composition of mill scale, or at least of its characteristic porous inner layer, which makes it possible for corrosion to attack the steel and loosen the scale-forming centers from which rust will extend. Mill scale forms in two layers, the inner one being represented by the formula $6\text{Fe} + \text{Fe}_2\text{O}_3$, and is very porous and brittle. The outer layer contains a larger but varying proportion of Fe_2O_3 . The air, and moisture contained in this porous scale tends to destroy the paint spread over it by starting corrosion. This scale is magnetic. A galvanic action is said to be set up around the edges, and corrosion commences there and afterward extends under the scale and outward under the paint. It is very important, therefore, that the mill scale be removed by some efficient means before the first coat of paint is applied.

With this digression I shall return now to the Evans high-pressure sand blast machine as applied to foundry work on both iron and steel castings. The machine is operated under a high pressure of from 90 to 100 lb. and will maintain steadily this or any desired pressure. This is rendered practical as the Evans uses a double hose connected at the nozzle, where the sand and the compressed air unite, each being brought to that point independently of the other, so there is no loss of pressure from friction. The free air passes through a turbine high velocity jet $3/16$ in. in diameter. The turbine principle, as you are all well aware, has developed the very highest type of steam engines, and it is this principle as applied to air, which we have adopted in our machine. The compressed air being expanded in the nozzle through this turbine high velocity jet, projects the sand from the end of the nozzle with a velocity of from 1200 to 1500 ft. per sec. The discharge in cubic feet of free air at the following pressures will show its great efficiency and the fact that it uses not more than one-quarter of the air of any other single hose machine:

Discharge of Air Through $3/16$ -In. Turbine Jet.

Air. cu. ft.	Pressure, lb.	Power required, hp.
60	80	11.8
76.5	90	15
83.8	100	17.5

This great saving in air means a correspond-

ing saving in horsepower. Again, the pressure is constantly maintained owing to the fact that the air which passes through the turbine jet, which is $3/16$ in. in diameter, can never vary. This jet will never increase in size as it is recessed back in the nozzle where the sand is forced through the sand and air hose into the mixing chamber or removable cone in the nozzle. The sand is then forced out through the tip of the nozzle by the pressure of air through the turbine jet, acquiring there a centrifugal or spiral motion which causes the sand to whirl and this motion going out through the tip of the nozzle at a high velocity strikes the object which is to be sand blasted and not only by the direct play of the stream of sand, but by the whirling motion, it scours off any scale on the castings caused by the flux or otherwise. This constant flow of air is of the very greatest importance not only from the standpoint of economy, but also from the standpoint of efficiency, as it will clean a given surface more rapidly than other machines, and will not use as much sand.

On the other hand, single hose machines will start with a nozzle opening of $3/8$ in. and will increase this opening, thereby increasing the flow of air and sand, which, of course, is caused by the fact of the sand and air passing out at the end of the nozzle. The sand wears out the nozzle very quickly and also the friction lessens the pressure and increases the horsepower required.

In conclusion there is no doubt that the numerous sand blast machines, which were originally designed for low-pressure machines, have been improved in every possible way to a high-pressure machine except at the one salient and important point, the nozzle, and the fact that they are and always will be single hose gives the double hose machine an enormous advantage. The principles which I have endeavored to explain to you I may say are basic principles, and, as applied to-day by us, show such wonderful advantages as will enable us to build machines which are adaptable for every kind of use where sand blasting may be used.

The quantity of natural gas necessary for the production of a ton of steel ingots by the open hearth process is about 5,500 cubic feet.

Having a heat value of 5,600 B. T. U.

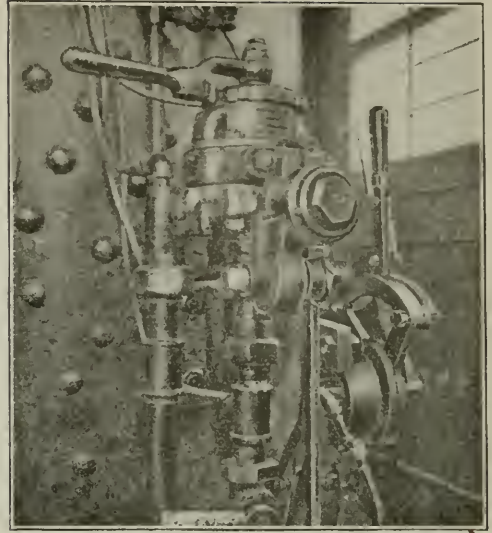
A NEW POWER REVERSE GEAR FOR A LOCOMOTIVE

The reversing of a heavy locomotive requires considerable physical strength, and when the operation has to be frequently repeated the suggestion of the use of mechanical power for the purpose is inevitable, and many arrangements have been devised for the purpose. It is becoming generally recognized by railway men that locomotives in switching service, equipped with power reverse gear, can handle a much larger tonnage than those without it, and as an adjunct to the efficiency and comfort of the crew, such equipment cannot profitably be overlooked.

The two illustrations here reproduced from *Railway Age Gazette* show the essential features of the Casey-Cavin reverse gear recently introduced by the Canadian Locomotive Company, Ltd., Kingston, Ont., and for which patents are pending in several countries.

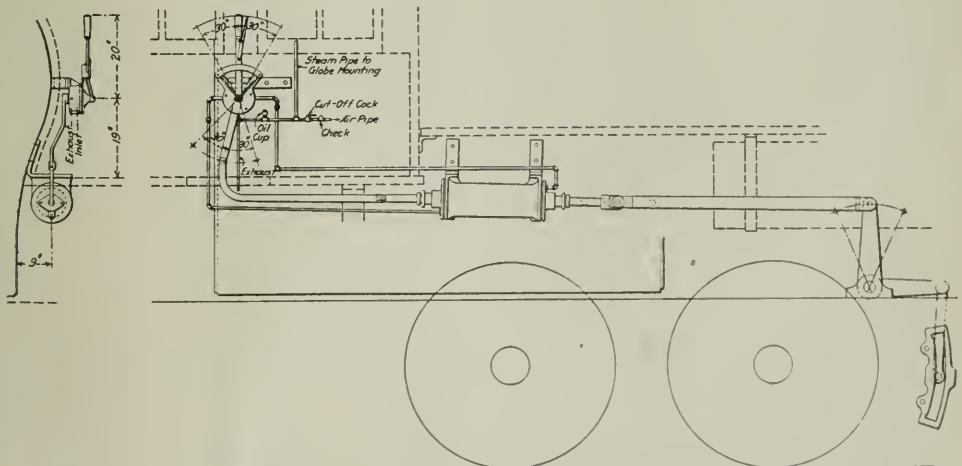
The illustrations show the general arrangement and also the controlling valve and lever in the cab. This application was made to some 0-6-0 type switching locomotives for the Canadian Northern.

The device consists essentially of a cylinder containing a piston, and rods so arranged as to shift the links or radius bars, and a valve containing two independently movable discs, one operated by the hand lever and the other by the connecting bar from the piston. These valve discs are so ported and arranged that on a movement of the hand controlled disc, pres-



REVERSE GEAR IN CAB.

sure is admitted to one end of the cylinder and exhausted from the other end, thereby producing a movement of the piston which brings the ports in the other disc to the same relation that they originally bore to the hand controlled disc. After either a complete reversal or only a "hooking-up" of the motion, the pressure is held on both sides of the piston, thereby locking it at any point. From this it will be seen that should any excessive strain be set up in the reach rod, causing a movement



GENERAL ARRANGEMENT OF REVERSE GEAR.

of the piston, a compensating admission of pressure would take place on the opposite side of the piston. The point of cut-off is indicated by the position of the lever on the quadrant, corresponding to the hand type of lever, thereby guarding against confusion to inexperienced enginemmen.

The cylinder is compact and can readily be attached to the boiler, firebox or running board in a substantial manner without interfering with other parts of the locomotive. The space occupied in the cab is very small, the travel of the handle being about 16 in.; the maximum pull necessary is from 12 to 15 lbs. The device is preferably operated by air pressure, but provision is made for the use of steam in the event of trouble with the air system. The total weight of the gear for a simple locomotive is about 375 lbs., and for a Mallet about 500 lbs.

Reports from applications made thus far are extremely satisfactory and seem to indicate that the device fills a long felt want, as it is reliable and at the same time so simple that it adds little or nothing to the cost of maintenance. A gear designed on similar lines and equipped with a positive mechanical locking device has also been developed by this company for fast passenger locomotives.

THE ONE-MAN DRILL*

It may be stated generally that in the Lake Superior copper district the average copper content of the rock decreases with depth. This has been the history of the district, and the cost of mining increases proportionately with depth. The Michigan copper mines are operating on rock containing lower copper content than the other copper-mining districts of the United States, and the Michigan copper mines are operating at greater depth, and consequently at greater cost, than the other copper mines of the United States. In order to compete, it is absolutely imperative that the mines of Michigan should be operated with the closest economy. The operators in Michigan have attempted to practise their greatest economy in the way of improved machinery and equipment, and the greatest step that has been made in this direction in recent years is the

installation of the one-man drill. A statement made by the superintendent of one of the mines, is as follows:

"The necessity for further close economy in the operation of our mine forced us to go into the market for a more efficient drilling machine, and, if possible, a machine that could be operated with one man as compared with two, which was standard practice. After about 18 months of experimenting the present machine was adopted. Our intention was to divide the benefits accruing to us from the use of the one-man machine with the men; this benefit to take the form of higher wages to machine operators (called miners). That this plan has been carried out is shown by the following table, which shows the increase in wages to the men operating one-man drills over wages made when operating two-men drills.

COMPARATIVE STATISTICS OF ONE-MAN DRILL AND TWO-MAN DRILL, CALUMET & HELCA AND SUBSIDIARY MINES, FOR THE YEAR ENDED DECEMBER 31, 1912.

	2-man drill.	1-man drill.
Shifts	350.012	54.758
Labor cost	\$1,024.801.84	\$193,935.81
Supplies	291,526.14	94,058.24
Total	1,316,327.98	287,994.05
Average wage per shift	2.83	3.34

"The miner's wages largely depend upon the efficiency of the man, as our work is all on the bonus system, and is so arranged that increased efficiency is of mutual benefit to the employer and the employee. We have a fixed contract which is not cut as the efficiency of the employee increases.

The committee made some inquiry as to how the one-man drill is received by miners in other copper districts, especially the Bisbee district of Arizona, and quotes from a letter received by it under date of September 29, 1913, from one of the mining engineers of the property of the Calumet & Arizona mine:

"The Company has in operation at the present time 100 one-man drills, which is 90 per cent. of the total number of drills now on development work. Sixty-five of these drills were purchased during the last four months. The one-man drill will no doubt replace all other larger drills in the near future.

*From report of Copper County Commercial Club.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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THE ATMOSPHERE THE UNIVERSAL WATER CARRIER

Among the most important of the atmospheric functions is the transportation and distribution of water over the earth. It not only spreads the water widely, but, to sustain this operation it must also somewhere be constantly picking up or absorbing in no less average quantities the water which it carries and delivers; and thus the air is, as circumstances may determine, not only a humidifier but also a desiccator. It not only wets things but it is equally able and ready to dry them when the conditions are reversed, and we may learn to profitably employ it for either service.

The changeable and controlling conditions spoken of are those of pressure and temperature, and especially the latter so far as the atmospheric transfer of moisture one way or the other is concerned. The various and unending changes of the weather, with which we are all our lives so familiar, are the resultants, or the accompaniments, of changes of atmospheric pressure or temperature, or usually of both; and the wonder must constantly be that so slight natural changes of these controlling conditions can produce results of such magnitude and extent. When we attempt to employ these atmospheric agencies for our industrial or other purposes we have to vastly exaggerate or intensify the changes in temperature or pressure which nature employs to enable us to accomplish results of any appreciable value.

The atmosphere never shows any let up in its water trading activities. Although it may never be said to be absolutely "dry" it absorbs water with avidity from almost anything that is "wet" with which it may come in contact, until the point of saturation is reached, and then the absorption suddenly ceases; but then it may be in condition to immediately reverse the process and become a dispenser of moisture, the dew-point being a point of unstable equilibrium.

In connection with the water carrying habit of the air we strike a curious paradox to which attention might be more generally directed with the purpose of leading to a better understanding of the phenomena involved. When at any time it happens to be evident to our unaided senses that there is an abnormal proportion of moisture in the air, or when the weather bureau is reporting that the percent-

age of humidity is high, it is commonly said that the air is heavy, or "laden with moisture," and the paradox is that the moister the air the lighter it is, and that dry air is the heaviest of all.

Say that we compare a cubic foot of dry air with a cubic foot of air saturated with moisture, assuming the air to have the same pressure and temperature in both cases. It is natural and easy to assume that the latter volume is the same as the former so far as the air is concerned, and that the water has in some way gotten into it, the weight of the water therefore being added to that of the air, which of course must make the total weight of the mixture greater than that of the air alone.

The simple fact—and not so simple after all—is that, although the water is so intimately and completely intermingled with the air, it still exists in the form of true vapor and occupies its due share of the space as such, displacing thereby so much of the air, and as water vapor alone is decidedly lighter than air alone so must any volume composed partly of air and partly of water vapor be lighter than an equal volume composed entirely of air.

FOREIGN LAWS FOR COMPRESSED AIR WORKERS

The following letter, reprinted from *Engineering News*, Sept. 18, will explain itself. It refers to the letter of Mr. Richards, reprinted at page 7001 of COMPRESSED AIR MAGAZINE, October, 1913. The new law referred to is at page 6998 of the same issue:

Referring to the New York law governing work under compressed air and to Mr. Frank Richards' letter about an oversight in said law in regard to proper ventilation of the lock during the period of decompression; it is evident that if the men were not taken dead out of the lock, as Mr. Richards fears, they would surely feel nauseated or have all the symptoms of the first stages of asphyxiation after spending half an hour or more in a crowded lock without ventilation.

As Mr. Richards states, the condition of the air in the heading of a tunnel may be expected to be much better than in a caisson, particularly so if the face is fairly open. This seems to be about the only reason [It looks like a kind of left-handed reason in this case. Editor C. A. M.] for the law to call for 24 min. for decompression from a 36-lb. pressure

and 40 min. from a 40-lb. pressure in a tunnel, whereas it calls for 20 min. for decompression from a pressure of 36 to 40 lb. when work is done in a caisson. Otherwise, it would seem that owing to cramped space and other disadvantages of the caisson work the men ought to be required to take more precautions and to spend more time in locking out than the men working in a tunnel.

The laws of the Netherlands and those of France regulating work in compressed air are more specific and more complete in so far as they relate to locking in and out and as to the lock itself. Article 28 of the Netherlands Regulations states that:

The lock must have an interior height of 1.80 m. and a floor area of 0.30 sq.m. per man up to a pressure of one atmosphere; of 0.35 sq.m. per man for a pressure of from one to two atmospheres and of 0.40 sq.m. per man for a pressure greater than two atmospheres; in the latter case benches must be provided so that the men may sit down.

Article 29—The ventilation of the lock shall be properly provided for.

Article 30—At the bottom of the lock shall be a removable perforated floor.

Article 31—Men shafts shall not be obstructed by tubes or pipes of any description.

Article 32—The lock shall be cooled or heated as the case may be unless means have been adopted to prevent the exterior temperature from having any direct influence thereon.

The French Law, enacted on Dec. 17, 1908, states:

Article 7—The volume of air per man in the lock will never be less than 0.6 cu.m. for any head of water up to 20m. and 0.7 cu.m. for any greater hydrostatic head.

The ventilation of the locks, during decompression lasting more than 10 min. shall be obtained by working simultaneously the valves controlling the inlet and outlet of the air to and from the locks, such valves being of different sizes.

In summer the locks exposed to the sun shall be protected by a tent or by straw mats sprinkled with water.

The supply of air will be such that the amount of carbonic acid in any sample of air taken at the longest distance from the point of delivery of the air pipe will not be greater than 1.5 in 1000 for pressures under two atmospheres and one in 1000 for higher pres-

tures; this percentage to correspond to a supply of 30 to 40 cu.m. of pure air per hour per man.

A sample of air will be taken and analysis thereof made whenever the supply of air will fall below 40 cu.m. per hour.

The passage through the lock during the decompression is often uncomfortable and this explains the haste with which the men are anxious to lock out. The proper ventilation of the lock will improve the quality of the air as well as prevent condensation to some extent.

This condensation and the resulting cold are chiefly objected to by the workmen, and this seems plausible enough since instances have occurred when the temperature dropped from 36 degrees C. to 5 degrees C. This condensation, however, is due to a rapid decompression; when this decompression is effected uniformly and at a speed of one-tenth of an atmosphere per minute, there is no appreciable condensation and hardly any drop in temperature, this lowering of temperature being opposed by the radiation of 300 to 400 calories given by the men, figured at an average of 75 calories per man per hour.

The French Law has not prescribed, as does the Dutch Law, the distribution of woollen clothing to the men when locking out, but requires that such recommendations as to clothing and other hygienic measures be printed and posted in the locks and about the works.

The great difficulty is to reconcile theoretical regulations and practice, and to convince the men of the necessity of using discretion in locking in and out. In view of the unwillingness of the men to spend the theoretical specified time in the lock, I found that the best way was to strike some happy medium by fitting the inlet and outlet valves with blank flanges, perforated in such a way that even by opening these valves in full, the time spent for compression or decompression would not be less than, say one-half to two-thirds the specified time and for long decompression to keep the exhaust valve open wide and the inlet valve partly open proportionately to the pressure and the theoretical time of decompression.

PAUL SEUROT.

Montreal, Can., Sept. 6, 1913.

"PRODUCTIVE" AND "NON-PRODUCTIVE"

Apparent absurdities frequently occur in our classifications of the productive and the non-productive in industrial operations. What is characterized as non-productive is always to be regarded deprecatingly, and economy is always to be assumed when the ratio of it to the whole is reduced; but how can anything, labor for instance, which is absolutely necessary in the orderly and profitable conducting of a business be called non-productive? There may not be any who would call the steam engine productive and the boiler non-productive, but they come near such foolishness in some other lines of record. The following from an esteemed contemporary, and for which it is not responsible, embodying definite and valuable information as to detail of mine operation is a sample of the general practice:

"The ratios of productive to non-productive work in some of the Butte shafts are as follows: Speculator, 1:2.12; Diamond, 1:1.52; High Ore, 1:3.34; Mountain View, 1:2.22 (A. I. M. E. Bulletin, September, 1913). These figures represent the ratio of effective horsepower developed in hoisting ore to effective horsepower developed in hoisting men and material. The greater consumption of horsepower in non-productive work is largely due to the fact that such operations are conducted out of balance and the dead load of skip, cage and rope is exceedingly heavy."

If the non-productive work of hoisting and lowering men and material should stop how much productive work would there be?

DISCOURAGING THE USE OF OZONE

An adverse report upon the properties of ozone has been made as a result of scientific investigations conducted on behalf of the official organ of the American Medical Association, by eminent bacteriologists. The report states that so far as the evidence goes, ozone produces no reaction in the human organism that can be regarded as in any degree beneficial in warding off infectious disease. On the contrary, all appreciable physiological changes produced by the inhalation of ozone are distinctly of an injurious and weakening character. The report goes on to say that while it is true that some bacteria are undoubtedly killed by ozone, especially if they are in a moist condition, and are in contact

for several hours with a current of ozone coming direct from the generator, the fact is of slight importance in practice. Human beings are injuriously affected by amounts of ozone far less than are necessary to produce even this slight bactericidal effect, and there is no evidence for supposing that, a quantity of ozone that can be tolerated by man has the least germicidal action. On the contrary, in concentrations that appreciably affect man and animals, ozone appears to have uniformly an injurious action, especially on the respiratory organs. Another objection to the use of ozone as an "air purifier" is that, while it has the property of masking bad odours, it destroys neither their cause nor effect. Since bad odours are danger signals, anything which tends to conceal them is obviously not in the best interests of hygiene.

NEW BOOK

Compressed Air Practice, By Frank Richards, McGraw-Hill Book Company, New York, IX+236 pages 6 by 9 in., nearly 100 illustrations, including full page half tones, numerous tables. Price \$3.00.

This book, by the managing editor of COMPRESSED AIR MAGAZINE, is different from all the other books on the subject. It is not a learned book; it is easily readable and understandable; it is written for the many rather than for the few, for those who know little about air rather than for those who mostly know all that is known about it. All air is compressed air, as the book assumes, and it has intimate relations not only with the vapor of water, which it always carries, and its own constituent gases, but with all the gases industrially employed, and air compressors find work in their manipulation, so that there is unlimited reach to the general subject. The titles of the chapters are strung together below:

Atmospheric generalities, Definitions and general information, The compressed air problem, Tables and charts for computations in air compression, The indicator on the air compressor, Single-stage compression, Two-stage compression, Two-stage and three-stage compression, Compressor regulating devices, The drive of the compressor. The turbo compressor, The Taylor compressor, Humphrey pump, Power cast of compressed air, Power from compressed air, The air receiver, Pipe trans-

mission, Reheating compressed air, Compressor and receiver fires and explosions, Side lines for the air compressor, Natural and artificial gas transmission, Gasoline by compression, Liquefied natural gas, Rock drill developments, Electric-air drill, Compressed air for raising water, Air-lift, Air for large stone hammers, Diving bell and caisson, Air jet, sand blast, cement gun, Liquid air, oxygen and nitrogen from the atmosphere.

THE NEW STANDARD DICTIONARY

Funk & Wagnalls' New Standard Dictionary of the English Language, the greatest of all the books, which has lately come as a permanent and valued addition to our reference table, is great in so many ways that it is not easy to determine where to begin to talk about it.

It is great in weight, 20 lb.; and in bulk, 600 cu. in. There are 3000 pages, 9 by 12 in., including inserts not numbered; there are 7000 illustrations, full page, double page, many in colors, and smaller cuts more than double as many as all the pages. The cuts are not inserted for pictorial effect or to promote the sale of the book, but are all pertinent to and explanatory of the text, making many things clearer to the inquirer.

The book is a monument and a not unworthy representative of the growth of thought and activity as exemplified in our written and spoken language to-day. The first regular English dictionary, Bailey's, which appeared nearly two centuries ago, contained 15,000 words, while the present Standard has thirty times as many, and dictionaries do not grow merely by adding words from time to time, but must be rewritten over and over again. We want not merely all the words, both old and new, but we must have more copious definitions of the words, more information of the use of them and of their relations. We scarcely needed to be told of the host of learned specialists and of the time that they have worked to produce this new book, because the evidence and the result of their labors crowds every page.

The book is made to be constantly used, and readiness and convenience are not least among its noticeable characteristics. There is an alphabetical arrangement which includes all the words, both the common words of the regular language and all the proper names, historical,

geographical, ultra-scientific, and the rest, so that there is no searching in different sections when a word or a name is wanted. You either find it at once or you don't find it, if that could happen, and whatever it is when found you are told just what you want to know about it, with almost invariably something which you did not know before. The dictionary is a great acquisition, as it must be to everyone who gets hold of it.

MASSACHUSETTS AIR RECEIVER INSPECTION LAW

The following is the substance of a newly-enacted law in Massachusetts, providing for the inspection of air receivers. The law has to do only with the use of compressed air for pneumatic tools and machinery:

1. No person shall install or use, or cause to be installed or used, any tank or other receptacle exceeding 18 inches in diameter for the keeping or storage of compressed air at any pressure exceeding .50 pounds per square inch for use in operating pneumatic machinery, unless the owner or user thereof shall hold a certificate of inspection issued by the boiler inspection department of the district police, certifying that the said tank or other receptacle has been duly inspected within two years, or unless the owner or user shall hold a policy of insurance upon the said tank or other receptacle issued by an insurance company operating under the laws of this commonwealth, together with a certificate of inspection from an insurance inspector.

2. The board of boiler rules shall prescribe regulations for the size, shape, construction, operation, minimum pressure, gages, safety devices and other appurtenances necessary for the safe operation of all tanks or other receptacles used for the storage of compressed air, except those exempted in section 7 of this act.

3. The boiler inspection department of the district police shall inspect all of the said tanks or other receptacles exceeding 18 inches in diameter and in excess of 50 pounds pressure per square inch at least once every two years; provided, however, that the said department shall not be required to inspect such tanks or other receptacles as may be covered by a policy of insurance and inspected by insurance inspectors.

4. All owners of any of the said tanks or

other receptacles exceeding 18 inches in diameter and in excess of 50 pounds pressure per square inch shall notify the chief of the district police of the location of the same.

5. Every insurance company authorized to insure air tanks within this commonwealth shall forward to the chief of the district police, within 14 days after each internal and external inspection of an air tank or other receptacle a report of such inspection. The reports shall be made on blanks furnished by the chief of the district police, and shall contain all orders and regulations made by the company regarding the air tanks or other receptacles so inspected.

6. The inspection shall consist of a hammer test, and also a hydrostatic test, the pressure of which shall be one and one-half times the pressure allowed on the air tank or other receptacle inspected. The air tank or other receptacle shall be prepared for inspection by the owner or user thereof.

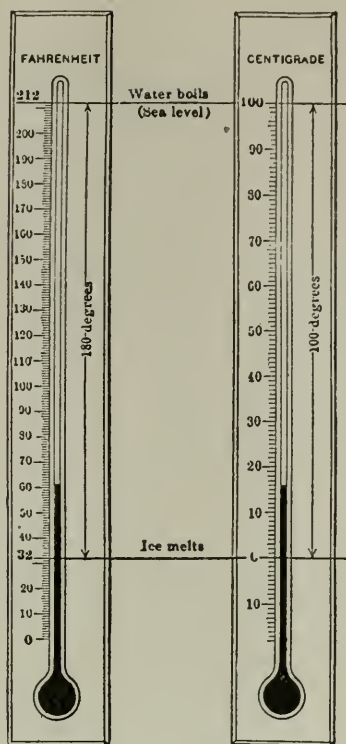
7. The provisions of this act shall not apply to tanks or other receptacles used for the keeping or storage of compressed air when attached to locomotives, street or railroad cars, vessels or motor vehicles.

8. The sum of \$3 shall be paid to the boiler inspection department of the district police by the owner or user of any such tank or other receptacle for every inspection thereof by the said department herein provided for.

9. Whoever violates any provision of this act, or any regulation made under authority hereof, shall be punished by a fine not exceeding \$50, or by imprisonment for not more than 30 days, or by both such fine and imprisonment.

CENTIGRADE AND FAHRENHEIT

The cut on the next page from *Coal Age*, if kept in sight, should serve as a handy reminder of the relations of the two scales. It is not necessary to go into the figures here as they are to be found in all the pocketbooks and elsewhere. It may be worth while to remind our readers that the Fahrenheit scale is nearly as much a centigrade scale as the other. Fahrenheit took the temperature of a mixture of salt and ice, the lowest then attainable, for his zero, and the temperature of human blood, as nearly as he could determine it, he made 100 degrees, and there you are.



THERMOMETERS COMPARED.

NOTES

The largest stone ever quarried has been found at Baalbec in Syria. It is 69 ft long, 14 ft. wide and 17 feet deep, and is estimated to weigh 1,400 tons.

The weight of the oxygen of the globe exceeds that of all other elements combined. It forms by weight about three-fourths of the animal, four-fifths of the vegetable, and one-half of the mineral worlds; also one-fifth by volume of the atmosphere and eight-ninths by weight of water.

Electricity, unlike other commodities, cannot with justice to the producer be sold at so much per unit regardless of who buys it or when he buys it. This is due to the fact that with respect to every customer the cost of producing it varies with the hour of the day and the nature of the customer's load.

An oil for use in exposed places in the winter time is produced by mixing graphite with

cylinder oil until the mass assumes a pasty consistency, and then adding enough kerosene to reduce the mixture to a freely flowing liquid. It is claimed that the oil thus produced will not stiffen in an atmosphere at the temperature of 14 degrees below zero.

According to "*Wasser und Wegebau Zeitschrift*" a new European record in tunneling was made last August in the building of the Swiss Hauenstein tunnel. The previous record was set in July, 1909, when 1013.5 ft. were broken out in the Loetschberg tunnel. The present record shows 1051.9 ft., thus exceeding the previous one by 38.4 ft.

Price of natural gas for domestic purposes in various states is as follows, in cents per 1000 cu. ft.: West Virginia, 18.12; Pennsylvania, 26.02; Ohio, 27.40; Kansas, 22.82; Oklahoma, 16.88; New York, 30.39; Indiana, 29.92; Louisiana, 22.84; Illinois, 22.85; Kentucky, 30.57; Texas, 39.73; and Alabama, 22.84 cents.

Hartford is the fourth city to return to the manufacture of coal gas in place of the water gas which has been used for a number of years, a discontinuance of which is being forced by the high price of petroleum. Derby, Ansonia and New Haven have already installed coal gas plants in place of those discarded some years ago, and the manufacture of coke has been resumed.

One of the first bores put down in Western Queensland to tap the great artesian storage in the interior of Australia was at Thargomindah, and the water from it is now being put to a novel use. The pressure is 270 lb. to the sq. in., yielding about 670,000 gallons per day. The bore is 2560 ft. deep, and the temperature of the water is 166 degrees. It drives a water wheel at 1200 r.p.m. to provide power for the local electric light system.

Little progress has been made in the United States in the use of ozone for water purification, owing to the excessive cost of the process. There are eight large cities in Europe using ozonated water, wherein the daily aggregate consumption is 39,600,000 gallons. The average cost of treatment is \$10 per 1,000,000 gallons. A small plant, having a daily capacity

of 80,000 gallons has been installed at Great Falls, S. C. It is claimed that the cost of treatment there does not exceed \$5.00 per 1,000,000 gallons.

It is understood that a great precooling, ice-making and refrigerating plant is to be built at the outer harbor of Los Angeles, to supply ice for harbor purposes, icing ships, etc., and to furnish cold storage facilities at the harbor.

A poultry man of Waltham, Mass., is using electric ozonizers to reduce mortality in the hatching and brooding of chicks. Ordinarily 24 to 40 hours elapse from the time the first chick peeps forth from its shell until the last one appears; but the use of ozone invigorates the chicks, as indicated by a recent hatching, which came out in ten hours. Furthermore, the chickens are uncommonly strong and robust.

We talk lightly of high vacua, or even of a perfect vacuum, says the *Scientific American*. It is instructive to calculate the number of molecules contained in a cubic millimeter of gas at the lowest pressure on record. W. Gaede has recently succeeded in exhausting a vessel to a pressure of two ten-millionths of a millimeter of mercury (four one-thousand-millionths of a pound, .000,000,004, per square inch). At this pressure one cubic millimeter of gas would still contain about 8,500,000 molecules.

The commissioners of northern lighthouses, Edinburgh, have in their charge ninety light-houses on the coast of Scotland. Up to the year 1900 the revolving lights were borne on rollers. The "float" system has been gradually introduced, however, and is now in operation at thirty coast stations and will be used at all others. The lighting machinery rests on a pontoon which runs on quicksilver in a groove. The quantity of mercury required for this purpose in a lighthouse is from seven to eight flasks of seventy-five pounds each. As the waste is trifling, the total present demand for this purpose is after all comparatively small.

The following is from the records of hoisting speeds in some leading British collieries:

Dowlais Mine, Cardiff, 2,220 ft. in 52 seconds, an average winding speed of 2,562 ft. per minute; Ashton Moss Colliery, 2,850 ft. in 1 minute 25 seconds, or 2,010 ft. per minute; Lady Windsor Colliery, 1,500 ft. in 35 seconds, or 2,571 ft. per minute; Bolsover Colliery, 1,116 ft. in 28 seconds, or 2,388 ft. per minute; Denaby and Cadeby Collieries, 2,289 ft. in 55 seconds, or 2,497 ft. per minute; Rhodes Rotherham Colliery, 1,650 ft. in 45 seconds, or 2,358 ft. per minute; while at the Rosebridge Colliery, a maximum hoisting speed of 5,100 ft. per minute has been recorded; but this is excessive, as, for considerations of safety, it should not exceed 4,000 ft. per minute.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

OCTOBER 7.

- 1,074,601. AIR-BRAKE. ROBERT D. BUSWELL, Wellington, Kans.
- 1,074,608. AIR SUCTION AND FORCE PUMP. FRANKLIN O. DE HYMEL, San Antonio, Tex.
- 1,074,744. VACUUM-CLEANER. HERBERT T. RODDEN, Chicago, Ill.
- 1,074,795. GAS-TESTING APPARATUS. EINER JOHNSON, Minneapolis, Minn.
- 1,074,797. PRESSURE - OPERATED DEEPWELL PUMP. PAUL G. KAISER, Chicago, Ill.
- 1,074,890. PNEUMATIC-CARRIER SYSTEM. FRANK W. NELSON, Chicago, Ill.
- 1,074,903. VACUUM-DRIER. OLIVER S. SLEEPER, Buffalo, N. Y.
- 1,074,920. PNEUMATIC CLEANER. ERNEST E. YAKLEY, Chicago, Ill.
- 1,074,934. SYSTEM OF STORING AND CONVEYING INFLAMMABLE AND OTHER LIQUIDS. HERMANN VON EICKEN, Friedenau, Germany.

1. In a system for storing or conveying liquids with the aid of a pressure fluid, the combination of a container having a safety outlet for said pressure fluid and adapted to contain said liquid, a jacket surrounding a portion of said container, a connection between said jacket and said safety outlet, and a body of sealing liquid contained in said connection and adapted to normally close said outlet, but to open it in the event of the jacket's leaking.

- 1,075,014-21. STATIONARY FIRE - EXTINGUISHER SYSTEM. ROBERT L. COONEY, Atlanta, Ga.

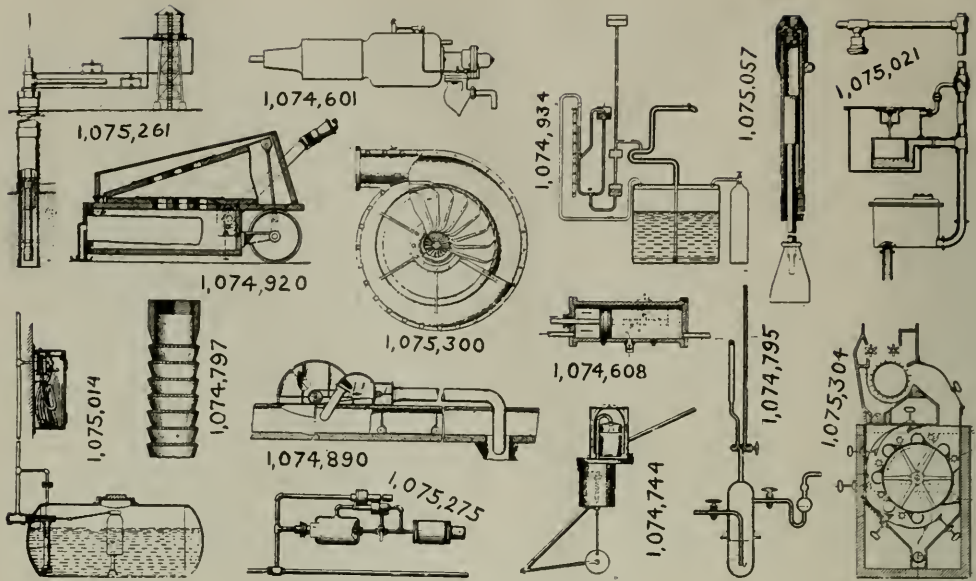
- 1,075,057. PNEUMATIC SAND - RAMMER. SAMUEL OLDHAM, Philadelphia, Pa.

- 1,075,085. WORKING WITH HYDROGEN UNDER PRESSURE. CARL BOSCH and FRANZ LAPPE, Ludwigshafen-on-the-Rhine, Germany.

In the process of working with hydrogen under increased pressure and at a raised temperature, interposing an atmosphere of nitrogen gas between the hydrogen and the hot pressure-sustaining wall of the reaction vessel.

- 1,075,091. STATIONARY FIRE-EXTINGUISHER SYSTEM. ROBERT L. COONEY, Atlanta, Ga.

1. A fire extinguisher system including means for maintaining two bodies of elastic fluid at normally balanced degrees of pressure, means for supplying a fire extinguishing agent, a supply system through which the agent flows, a valve operable whereby the degree of pressure



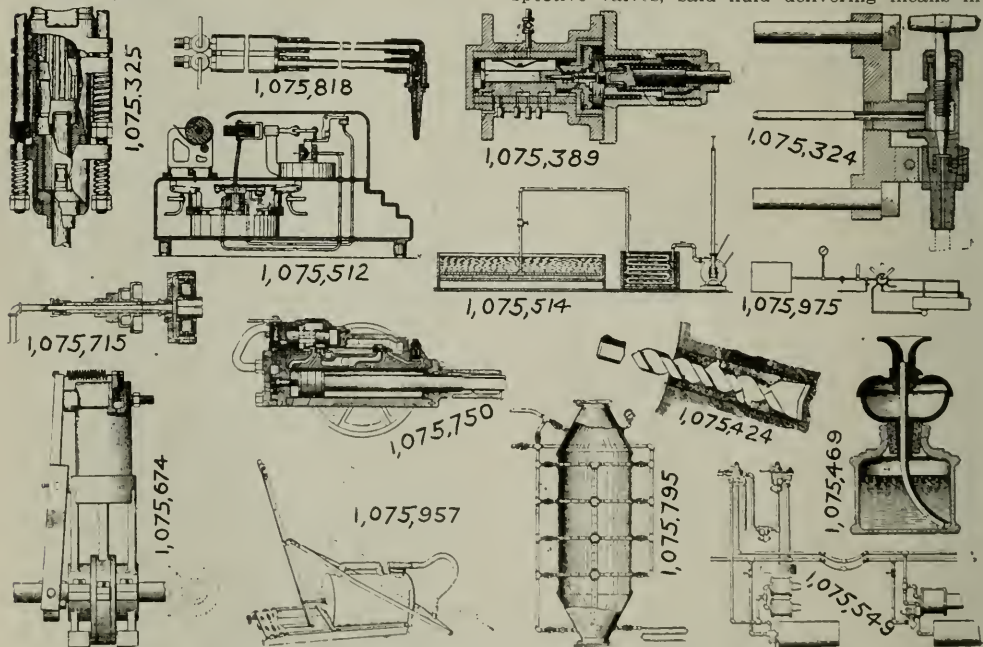
PNEUMATIC PATENTS OCTOBER 7.

of one body may be initially reduced and means whereby the other pressure by virtue of its expansive nature becomes active upon the initial reduction of the first pressure to cause the operation of the fire extinguisher agent supply means.

1,075,197. AIR-CONDITIONING APPARATUS. STUART W. CRAMER and WILLIAM B. HODGE, Charlotte, N. C.

1,075,261. WELL-CLEANING DEVICE. JOHN FRANKLIN KILBURN, El Paso, Tex.

1. In a device of the class set forth, the combination of a working barrel, a foot valve therein, a plunger and sucker valve above the foot valve, and means to deliver fluid under high pressure into and through different parts of the working barrel and into the region of the respective valves, said fluid delivering means in-



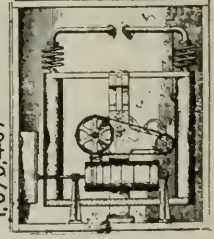
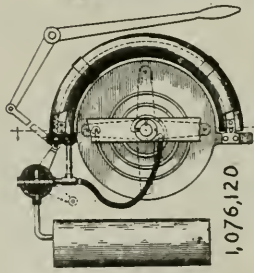
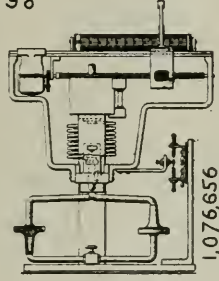
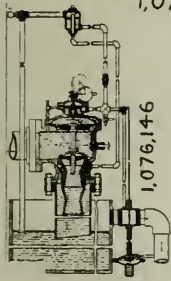
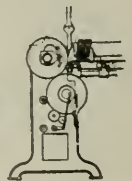
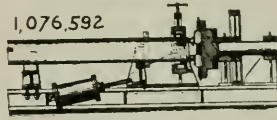
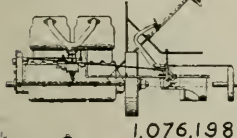
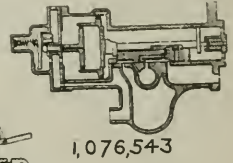
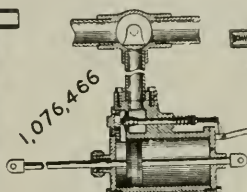
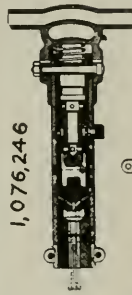
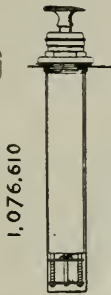
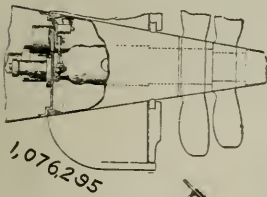
PNEUMATIC PATENTS OCTOBER 14.

cluding longitudinal passageways formed in and through the wall of the working barrel and communicating with the interior thereof just above said valves and tubes tapped into the ends of said passageways.

- 1,075,275. LOAD-BRAKE APPARATUS. WALTER V. TURNER, Wilkensburg, Pa.
1,075,300. CENTRIFUGAL COMPRESSOR. SANFORD A. Moss, Lynn, Mass.
1,075,304. PNEUMATIC CLEANING DEVICE. CECIL L. SAUNDERS, Hot Springs, Ark.

OCTOBER 14.

- 1,075,324. VALVED CONNECTION FOR ROCK-DRILLS. SANFORD W. BROTHERS, Denver, Colo.
1,075,325. LOCKING - CHUCK FOR ROCK-DRILLS, ETC. SANFORD W. BROTHERS, Denver, Colo.



PNEUMATIC PATENTS OCTOBER 21.

- 1,075,389. EMPTY AND LOAD BRAKE. WALTER V. TURNER, Edgewood, Pa.
1,075,424. ROCK-DRILL. CORWILL JACKSON, Madison, Wis.
1,075,469. PNEUMATIC ATTACHMENT FOR INK-RECEPTACLES. HENRY T. EMEIS, San Diego, Cal.
1,075,512. PNEUMATIC TYPE-WRITER. MAX SOBLIK, Dresden-Klotzsche, Germany.
1,075,514. PROCESS OF TREATING CREAM AND SIMILAR SUBSTANCES. FRANKLIN H. STANLEY, Cleveland, Ohio.
1,075,549. COMBINED AUTOMATIC AND STRAIGHT-AIR BRAKE. JOHN W. CLOUD, London, England.
1,075,674. AIR-PUMP. FRANK E. TEN EYCK, Boston, Mass.

1. In a pump of the class described, the combination with the piston operating devices adapted to be loosely mounted on an actuating shaft, a clutch for connecting said shaft and the piston operating devices, a lever for operating said clutch, an air pressure piston connected with said pump for operating the said lever by the pressure within the pump cylinder and its connections.

- 1,075,715. FLUID - ACTUATED LATHE-CHUCK. HARLAN M. LUDWICK, Parkesburg, Pa.

- 1,075,750. DIRECT-ACTING ENGINE. ALBERT BALL and THOMAS OFFICER, Claremont, N. H.

- 1,075,790. PNEUMATIC - DESPATCH - TUBE APPARATUS. ALBERT W. PEARSALL, Lowell, Mass.

- 1,075,795. METHOD AND APPARATUS FOR DIGESTING WOOD AND OTHER FIBROUS MATERIALS. JOHN CHARLES WILLIAM STANLEY, Santa Cruz, Cal.

1. The process herein described for the digestion of fibrous material, said process consisting in immersing the material in a disintegrating solution; admitting a heating agent into the interior of the mass and subjecting the mass to the action of the heating agent until the mass is cooked, then draining off and condensing said

solution; then admitting compressed air into the container above said mass to thereby create a pressure upon the mass in excess of that of the heating agent and to squeeze out of the mass the remaining surplus solution.

- 1,075,818. BLOWPIPE AND METHOD OF USING GASES THEREIN. MELBOURNE K. DUNHAM, Boston, Mass.

1. The method of using oxygen and a combustible gas, such as acetylene, in a blow pipe which has a mixing chamber and a burner passage leading therefrom, which consists in delivering the acetylene gas directly into the mixing chamber from the rear and allowing oxygen held under a high pressure to expand into a chamber which is separate from but surrounds the mixing chamber and the acetylene gas passage leading thereto whereby the reduction of temperature caused by the expanding action of the oxygen gas counteracts, the heating effect produced by the flame on the acetylene gas being delivered to the mixing chamber so that the gases are delivered to the mixing chamber at somewhere near the same temperature.

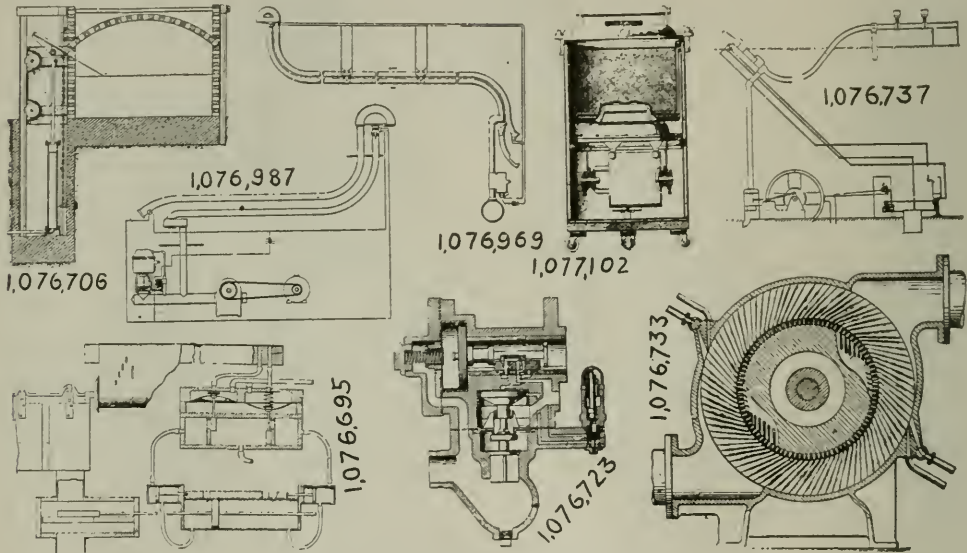
- 1,075,906. SANITARY SAND-BLAST HELMET. WILLIAM DUNCAN and JOHN A. SPANGLER, Attica, Ind.

- 1,075,957. VACUUM - CLEANER. JOHN B. YOUNG, North Crystal Lake, Ill.
 1,075,975. ENGINE-STARTER. JOHN HUME, Houston, Tex.

OCTOBER 21.

- 1,076,057. FEEDING ATTACHMENT FOR PNEUMATIC STACKERS. JOHN W. PLUMMER, Morrill, Nebr.
 1,076,069. ELECTROPNEUMATIC SWELL-PEDAL ACTION FOR PIPE-ORGANS. ERNEST M. SKINNER, Boston, Mass.
 1,076,120. STARTING DEVICE FOR EXPLOSIVE-ENGINES. JOHN O. HOBBS, Chicago, Ill.

1. In a starting device for explosive engines, the combination with a starting shaft, of a crank loosely mounted upon said shaft, means for applying fluid pressure to said crank, a fluid pressure operated crank for locking said crank to said shaft, valve mechanism for controlling the application of fluid pressure to said crank and to said clutch, means for manually operating said valve mechanism to apply fluid pressure to said crank and to said clutch, and means automatically actuated by said crank for releasing fluid pressure therefrom and from said clutch.



PNEUMATIC PATENTS OCTOBER 28.

- 1,076,134. PIPE-FLANGING MACHINE. JOHN H. MANNING, New York, N. Y.
 1,076,146. VACUUM-CONTROLLED DIFFERENTIAL-LIQUID-LEVEL APPARATUS. EDWARD P. NOYES, Winchester, Mass.
 1,076,198. VACUUM-BRAKE. JAMES T. DICKSON, Los Angeles, Cal.
 1,076,246. ROCK-DRILL. GRANT W. SMITH, Chattanooga, Tenn.
 1,076,295. SINKING DEVICE FOR AUTOMOBILE TORPEDOES. FRANK M. LEAVITT, Smithtown, N. Y.
 1. In an automobile torpedo, a spring-closed exhaust-valve opening from an air chamber within the shell, and means for holding said valve open when it has been opened by the escaping air to admit water to said chamber after the run to sink the torpedo.
 1,076,391. ROTARY BLOWER. GEORGE L. REICHHELM, Jersey City, N. J.
 1,076,437. FLUID-FLOW METER. HAROLD H. MAPELSDEN, Schenectady, N. Y.

- 1,076,462. PUMP FOR ELASTIC FLUIDS. KARL STEINBECKER, Charlottenburg, Germany.
 1,076,466. AUTOMATIC BRAKE MECHANISM. WILBER B. THOMAS, Salem, Ohio.
 1,076,491. PNEUMATIC PRESS - FEEDING MEANS. JAMES DUVALL, Camas, Wash.
 1,076,543. AIR-BRAKE APPARATUS. HENRY F. BICKEL, Plainfield, N. J.
 1,076,549. PNEUMATIC BRUSH. ISAAC CHAIMOVITSCH, Chicago, Ill.
 1,076,592. PROCESS OF PIPE-FLANGING. JOHN H. MANNING, New York, N. Y.
 1,076,610. AIR-PUMP. LINCOLN B. SHERWOOD, Indianapolis, Ind.
 1,076,656. FLUID-FLOW METER. HAROLD H. MAPELSDEN, Schenectady, N. Y.

OCTOBER 28.

- 1,076,664. FLUID-PRESSURE BRAKE. JOHN W. CLOUD, London, England.
 1,076,695. AUTOMATIC TEMPO-REGULATOR. PAUL B. OLSON, Chicago, Ill.
 1,076,706. CHARGING APPARATUS. HARRY JOSEPH ROWE, New Kensington, Pa.
 1,076,723. FLUID-PRESSURE BRAKE. WALTER V. TURNER, Edgewood, Pa.
 1,076,733. TURBINE. EMIL ANDERSON, New York, N. Y.

- 1,076,737. PNEUMATIC - DESPATCH - TUBE SYSTEM. BIRNEY C. BATCHELLER, New York, N. Y.
 1,076,969. PNEUMATIC - DESPATCH - TUBE APPARATUS. EDMOND A. FORDYCE, Boston, Mass.
 1,076,987. PNEUMATIC - DESPATCH - TUBE APPARATUS. JAMES G. MACLAREN, Harrison, N. Y.
 1,076,989. PNEUMATIC CONVEYER SYSTEM. WILLIAM McCCLAVE, Scranton, Pa.
 1,077,034. PROCESS OF WORKING WITH HYDROGEN UNDER PRESSURE. CARL BOSCH, Ludwigshafen-on-the-Rhine, Germany.
 1,077,102. VACUUM-CLEANER. JOHN W. SMITH, Chicago, Ill.
 1,077,181. APPARATUS FOR USE BY PERSONS WORKING IN IRRESPIRABLE ATMOSPHERES OR UNDER WATER. ARTHUR THOMAS WINBORN, Crumlin, Wales.

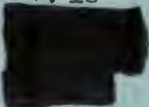
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